ARMY
13.1 Small Business Innovation Research (SBIR)
Proposal Submission Instructions

INTRODUCTION

The US Army Research, Development, and Engineering Command (RDECOM) is responsible for execution of the Army SBIR Program. Information on the Army SBIR Program can be found at the following Web site: https://www.armysbir.army.mil.

Solicitation, topic, and general questions regarding the SBIR Program should be addressed according to the DoD Program Solicitation. For technical questions about the topic during the pre-release period, contact the Topic Authors listed for each topic in the Solicitation. To obtain answers to technical questions during the formal Solicitation period, visit http://www.dodsbir.net/sitis. Specific questions pertaining to the Army SBIR Program should be submitted to:

John Smith
Program Manager, Army SBIR
army.sbir@us.army.mil
US Army Research, Development and Engineering Command (RDECOM)

ATTN: AMSRD-PEB
3071 Aberdeen Blvd.
Aberdeen Proving Ground, MD 21005-5201
TEL: (703) 399-2049
FAX: (703) 997-6589

The Army participates in three DoD SBIR Solicitations each year. Proposals not conforming to the terms of this Solicitation will not be considered. Only Government personnel will evaluate proposals.

Please note, due to recent changes in SBIR policy, Phase II efforts following a Phase I award resulting from the 11.1 and subsequent Solicitations will have a maximum dollar amount of $1,000,000. Phase II efforts following a Phase I award prior to the 11.1 Solicitation will continue to have a maximum dollar amount of $730,000.

PHASE I PROPOSAL SUBMISSION

SBIR Phase I Proposals have 4 Volumes: Proposal Cover Sheets, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in others sections of the proposal submission as THESE WILL COUNT AGAINST THE 20 PAGE LIMIT. ONLY the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. As instructed in Section 5.4e of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the "Company Commercialization Report" tool. Army Phase I proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated.

Phase I proposals must describe the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more

Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

Phase I proposals will be reviewed for overall merit based upon the criteria in Section 6.0 of the DoD Program Solicitation.

PHASE I OPTION MUST BE INCLUDED AS PART OF PHASE I PROPOSAL

The Army implements the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to have the Phase I Option exercised. The Phase I Option, which **must** be included as part of the Phase I proposal, should cover activities over a period of up to four months and describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The Phase I Option must be included within the 20-page limit for the Phase I proposal.

PHASE I COST VOLUMES

A firm fixed price or cost plus fixed fee Phase I Cost Volume ($150,000 maximum) must be submitted in detail online. Proposers that participate in this solicitation must complete Phase I Cost Volume not to exceed a maximum dollar amount of $100,000 and six months. A Phase I Option Cost Volume not to exceed a maximum dollar amount of $50,000 and four months. The Phase I and Phase I Option costs must be shown separately but may be presented side-by-side in a single Cost Volume. The Cost Volume DOES NOT count toward the 20-page Phase I proposal limitation. When submitting the Cost Volume, complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal.

Phase I Key Dates

Phase I Evaluations	January – February 2013
Phase I Selections	March 2013
Phase I Awards	May 2013*

**Subject to the Congressional Budget process*

PHASE II PROPOSAL SUBMISSION

Invitations are no longer required to submit a Phase II proposal.

Phase II proposals can be submitted by Phase I awardees only within one of four submission cycles (30 calendar days starting in mid-October, early March, mid-June and early August. Specific dates for each of these periods are available at www.armysbir.army.mil); **and** must be submitted between 5 to 17 months after the Phase I contract award date. Any proposals that are not submitted within these four submission cycles and before 5 months or after 17 months from Phase I contract award will not be evaluated.

DoD is not obligated to make any awards under Phase I, II, or III. For specifics regarding the evaluation and award of Phase I or II contracts, please read the DoD Program Solicitation very carefully. Phase II proposals will be reviewed for overall merit based upon the criteria in Section 8.0 of the solicitation.

Small businesses submitting a proposal are required to develop and submit a technology transition and commercialization plan describing feasible approaches for transitioning and/or commercializing the developed technology in their Phase II proposal. Army Phase II Cost Volumes must contain a budget for the entire 24 month Phase II period not to exceed the maximum dollar amount of $1,000,000. During contract negotiation, the contracting officer may require a Cost Volume for a base year and an option year. These costs must be submitted using the Cost Volume format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Volume Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

SBIR Phase II Proposals have 4 sections: Proposal Cover Sheets, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 38-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in others sections of the proposal submission as THESE WILL COUNT AGAINST THE 38 PAGE LIMIT. ONLY the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 38-page limit. As instructed in Section 5.4e of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the "Company Commercialization Report" tool. Army Phase II proposals submitted over 38-pages will be deemed NON-COMPLIANT and will not be evaluated.

BIO HAZARD MATERIAL AND RESEARCH INVOLVING ANIMAL OR HUMAN SUBJECTS

Any proposal involving the use of Bio Hazard Materials must identify in the Technical Volume whether the contractor has been certified by the Government to perform Bio Level - I, II or III work.

Companies should plan carefully for research involving animal or human subjects, or requiring access to government resources of any kind. Animal or human research must be based on formal protocols that are reviewed and approved both locally and through the Army's committee process. Resources such as equipment, reagents, samples, data, facilities, troops or recruits, and so forth, must all be arranged carefully. The few months available for a Phase I effort may preclude plans including these elements, unless coordinated before a contract is awarded.

FOREIGN NATIONALS

If the offeror proposes to use a foreign national(s) [any person who is NOT a citizen or national of the United States, a lawful permanent resident, or a protected individual as defined by 8 U.S.C. 1324b (a) (3) – refer to Section 3.4 of this solicitation for definitions of "lawful permanent resident" and "protected individual"] as key personnel, they must be clearly identified. **For foreign nationals, you must provide country of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project. Please ensure no Privacy Act information is included in this submittal.**

OZONE CHEMICALS

Class 1 Ozone Depleting Chemicals/Ozone Depleting Substances are prohibited and will not be allowed for use in this procurement without prior Government approval.

CONTRACTOR MANPOWER REPORTING APPLICATION (CMRA)

The Contractor Manpower Reporting Application (CMRA) is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. This reporting requirement applies to all Army SBIR contracts.

Offerors are instructed to include an estimate for the cost of complying with CMRA as part of the Cost Volume for Phase I ($100,000 maximum), Phase I Option ($50,000 maximum), and Phase II ($1,000,000 maximum), under “CMRA Compliance” in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMRA requirement. Only proposals that receive an award will be required to deliver CMRA reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMRA.

To date, there has been a wide range of estimated costs for CMRA. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR Program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMRA as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMRA System. The CMRA Web site is located here: https://cmra.army.mil/.

- The CMRA requirement consists of the following items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:

  (1) Contract number, including task and delivery order number;
  (2) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
  (3) Estimated direct labor hours (including sub-contractors);
  (4) Estimated direct labor dollars paid this reporting period (including sub-contractors);
  (5) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
  (6) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
  (7) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on Web site);

- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

- According to the required CMRA contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government Web site. The CMRA Web site also has a no-cost CMRA XML Converter Tool.

Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMRA is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee.

Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed $500.00 annually, or to be included in overhead rates.

DISCRETIONARY TECHNICAL ASSISTANCE

In accordance with section 9(q) of the Small Business Act (15 U.S.C. 638(q)), the Army will provide technical assistance services to small businesses engaged in SBIR projects through a network of scientists and engineers engaged in a wide range of technologies. The objective of this effort is to increase Army

SBIR technology transition and commercialization success thereby accelerating the fielding of capabilities to Soldiers and to benefit the nation through stimulated technological innovation, improved manufacturing capability, and increased competition, productivity, and economic growth.

The Army has stationed six Technical Assistance Advocates (TAAs) across the Army to provide technical assistance to small businesses that have Phase I and Phase II projects with the participating organizations within their regions.

For more information go to: https://www.armysbir.army.mil/sbir/TechnicalAssistance.aspx.

COMMERCIALIZATION READINESS PROGRAM (CRP)

The objective of the CRP effort is to increase Army SBIR technology transition and commercialization success and accelerate the fielding of capabilities to Soldiers. The CRP: 1) assesses and identifies SBIR projects and companies with high transition potential that meet high priority requirements; 2) matches SBIR companies to customers and facilitates collaboration; 3) facilitates detailed technology transition plans and agreements; 4) makes recommendations for additional funding for select SBIR projects that meet the criteria identified above; and 5) tracks metrics and measures results for the SBIR projects within the CRP.

Based on its assessment of the SBIR project's potential for transition as described above, the Army utilizes a CRP investment fund of SBIR dollars targeted to enhance ongoing Phase II activities with expanded research, development, test and evaluation to accelerate transition and commercialization. The CRP investment fund must be expended according to all applicable SBIR policy on existing Phase II contracts. The size and timing of these enhancements is dictated by the specific research requirements, availability of matching funds, proposed transition strategies, and individual contracting arrangements.

NON-PROPRIETARY SUMMARY REPORTS

All award winners must submit a non-proprietary summary report at the end of their Phase I project and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should include:

- A summation of Phase I results
- A description of the technology being developed
- The anticipated DoD and/or non-DoD customer
- The plan to transition the SBIR developed technology to the customer
- The anticipated applications/benefits for government and/or private sector use
- An image depicting the developed technology

The non-proprietary summary report should not exceed 700 words, and is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. The summary report shall be submitted in accordance with the format and instructions posted within the Army SBIR Small Business Portal at https://portal.armysbir.army.mil/SmallBusinessPortal/Default.aspx and is due within 30 days of the contract end date.

ARMY SUBMISSION OF FINAL TECHNICAL REPORTS

A final technical report is required for each project. Per DFARS clause 252.235-7011 (http://www.acq.osd.mil/dpap/dars/dfars/html/current/252235.htm#252.235-7011), each contractor shall (a) submit two copies of the approved scientific or technical report delivered under the contract to the

Defense Technical Information Center, Attn: DTIC-O, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218; (b) Include a completed Standard Form 298, Report Documentation Page, with each copy of the report; and (c) For submission of reports in other than paper copy, contact the Defense Technical Information Center or follow the instructions at http://www.dtic.mil.

ARMY SBIR PROGRAM COORDINATORS (PC) and Army SBIR 13.1 Topic Index

Participating Organizations		PC	Phone
Aviation Missile RD&E Center (AMRDEC A)		**Linda Taylor**	**(256) 876-2883**
A13-001	Rear Hemisphere Tail-Rotor Obstacle Avoidance for Unmanned & Manned Rotorcraft		
A13-002	Durable, CMAS resistant, thermal/environmental barrier coatings for metallic and CMC hot section components of gas turbine engines		
A13-003	Effective Processes to Manufacture Advanced Combustion Liners with Shaped Film Cooling Holes for Gas Turbine Engines		
A13-004	Surface Mesh Refinement Guide Tool for Computational Fluid Dynamics Applications		
Aviation Missile RD&E Center (AMRDEC M)		**Otho Thomas** **Dawn Gratz**	**(256) 842-9227** **(256) 842-8769**
A13-005	Short Duration, High Altitude, Mixed Continuum/Non-Continuum Flowfield		
A13-006	Afterburning Missile Base Flow Modeling and Analyses		
A13-007	Automated trace gas molecular analyzer using rotational spectroscopy		
A13-008	All-solid-state Hybrid Energy Storage System (Battery-Ultracapacitor)		
Armaments RD&E Center (ARDEC)		**Carol L'Hommedieu**	**(973) 724-4029**
A13-009	Super-black Metallic Surfaces		
A13-010	Development of Ductile, Bulk Tungsten for Next Generation Munitions and Warheads		
A13-011	Advanced hybrid graphitic materials for enhanced energetic applications		
A13-012	Novel Control Technologies for Guidance of High-Spin Stabilized Munitions		
A13-013	Low Energy Consumption Compact Control Actuation Systems for Precision Guided Artillery and Mortar Munitions		
Army Research Laboratory		**Mary Cantrill**	**(301) 394-3492**
A13-014	Tactical Wireless Ground Sensor Network Deployment and Maintenance System		
A13-015	Skin Attached Traumatic Brain Injury Sensing System		
A13-016	Identification of Material Damage Precursors using novel Nondestructive Evaluation and/or Structural Health Monitoring Hardware		
A13-017	Secondary Processing Development and Prototyping of Cast Single-Piece Vehicle Underbody Structure		
A13-018	Development of linear/non-linear radar system		
A13-019	Determination of Terrain Ponding for Logistics Emplacement and Planning		
A13-020	Nano-Inspired Broadband Photovoltaics Sheets		
A13-021	Non-linear Dynamic Energy Altering Technologies for Body Armor Applications		
A13-022	Survivability Improvements for Transmission Loss-of-Lubrication		
A13-025	Wearable Sensor System for Monitoring Soldier Body Dynamics		
A13-026	Wide Field-of-View Imaging System with Active Mitigation of Turbulence Effects for Tactical Applications		
Army Test and Evaluation Command		**Nancy Weinbrenner -Savage**	**(443) 861-9346**
A13-027	Vehicle Spacing Determination and Display In Low Visibility Conditions		
A13-028	Advanced Spectrum Monitoring		
Communications-Electronics RD&E Center		**Patricia Thomas**	**(443)861-7587**
A13-029	Optimization of Real Time Image Processing Techniques for Low Power Soldier and Unattended Ground Sensors		

A13-030	Data Disassembler/Reassembler
A13-031	Enabling Dynamic Initialization Products
A13-032	Common Software Foundation
A13-033	An Ad-hoc Network of Smartphones with RF Ranging Capability
A13-034	Tactical Network Configuration (NETCONF)
A13-035	Improving Battlefield System Usability
A13-036	Vehicle Mounted LIDAR Standoff Roadside Hazard Detection
A13-037	Compact Full-Framing Hyperspectral Sensor for On-The-Move Ground-to-Ground Applications
A13-038	Intelligence Requirements Management (IRM)
A13-039	Amplifier Linearization Module
A13-040	Electro-Optically Guided Radar Imaging
A13-041	Signal Recognition and Management Band Pass Filter (BPF) Devices
A13-042	Improved performance of small pixel infrared detector focal plane arrays via in situ mesa sidewall characterization

Edgewood Chemical Biological Center	**Dhirajal Parekh**	**(410) 436-8400**
	Martha Weeks	**(410) 436-5391**

A13-043 Ordered Packing and Efficient Aerosolization of Anisotropic Particles
A13-044 Development of advance obscurants materials using synthesis of metallic hollow nanoparticles

Natick Soldier Center	**Cathy Polito**	**(508) 233-5372**

A13-045 Battle Fuel Conditioner (BFC) for Commercial Gas Appliances in Field Kitchens
A13-046 Self Contained/Self Powering Solutions for Protective Eyewear Employing Active Lens Technologies
A13-047 Novel Textile for Use on Low Cost Parachutes Employing Trigger Technology to Rapidly Degrade
A13-048 Non-toxic Insect-resistant Textiles for Military Clothing and Equipment

PEO Ammunition	**Vince Matrisciano**	**(973) 724-2765**

A13-049 Innovative Technologies for Miniaturized Affordable Battlefield Hardened Proximity Sensor
A13-050 Miniature Actuator Controls for 40mm Guided and Surveillance Projectiles

PEO Aviation	**David Weller**	**(256) 313-4975**

A13-023 Wireless Sensor to Monitor Generator Control Unit and Main Power Relay Health
A13-024 Advanced High Speed Overrunning Clutch for Rotorcraft Transmissions

PEO Combat Support & Combat Service Support	**Matthew Raubinger**	**(586) 282-1430**

A13-051 Intelligent Charge Control System w/Anti-Idle to Minimize Fuel Consumption
A13-060 Portable Fuel Analyzer

PEO Ground Combat Systems	**Erik Kallio**	**(586) 282-0203**

A13-052 Modeling of Complex Environment for Unmanned Ground Vehicles Performance Evaluations
A13-061 Develop Efficient/Leak Proof M1 Abrams Plenum Seal

PEO Missiles and Space	**Myron Chenault**	**(256) 876-5527**
	George Burruss	**(256) 313-3523**

A13-053 High Bandwidth, Compact, Wireless, Millimeter Wave Intra-Missile Datalink
A13-054 Advanced Warhead Design
A13-055 Advanced Waveform Design and Signal Processing

PEO Simulation, Training and Instrumentation	**Rob Forbis**	**(407) 384-3884**

A13-056 Urban Computer Generated Forces (CGF) Models
A13-057 Tactical Engagement Simulation System (TESS) Improved Laser Encoding and Decoding

Space and Missile Defense Command	**Gary Mayes**	**(256) 955-4904**

A13-058 Non-Lethal Munitions for Defeating Improvised Explosive Devices (IEDs)

A13-059	Innovative Technology for Secure Cloud Computing

Tank Automotive RD&E Center (TARDEC) **Martin Novak** **(586) 282-8730**

A13-062	Stand Alone Sensor for Air Bag and Restraint System Activation In An Underbody Blast Event
A13-063	Dual-Function 3D Fiber-Reinforced Transparent Material for Ballistic Protection and Shock Attenuation
A13-064	Hands Free Automatic Coupling Restraint System
A13-065	Encapsulated Air Energy Absorbing Flooring
A13-066	Supplemental External Expendable Radiator (SEER)
A13-067	Fuel Efficient Military Tire
A13-068	Advanced Human Robot Interaction to create Human-Robot Teams
A13-069	Friction Material (brake pads) for Metal Matrix Drums

DEPARTMENT OF THE ARMY PROPOSAL CHECKLIST

This is a Checklist of Army Requirements for your proposal. Please review the checklist to ensure that your proposal meets the Army SBIR requirements. You must also meet the general DoD requirements specified in the solicitation. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award**. Do not include this checklist with your proposal.

1. The proposal addresses a Phase I effort (up to **$100,000** with up to a six-month duration) AND (if applicable) an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

2. The proposal is limited to only **ONE** Army Solicitation topic.

3. The technical content of the proposal, including the Option, includes the items identified in Section 5.3 of the Solicitation.

4. SBIR Phase I Proposals have 4 sections: Proposal Cover Sheets, Technical Volume, Cost Volume and Company Commercialization Report. The Technical Volume has a 20-page limit including, but not limited to: table of contents, pages intentionally left blank, references, letters of support, appendices, technical portions of subcontract documents [e.g., statements of work and resumes] and all attachments). However, offerors are instructed to NOT leave blank pages, duplicate the electronically generated cover pages or put information normally associated with the Technical Volume in others sections of the proposal submission as THESE WILL COUNT AGAINST THE 20 PAGE LIMIT. ONLY the electronically generated Cover Sheets, Cost Volume and Company Commercialization Report (CCR) are excluded from the 20-page limit. As instructed in Section 3.5.d of the DoD Program Solicitation, the CCR is generated by the submission website, based on information provided by you through the "Company Commercialization Report" tool. Army Phase I proposals submitted over 20-pages will be deemed NON-COMPLIANT and will not be evaluated.

5. The Cost Volume has been completed and submitted for both **the Phase I and Phase I Option** and the costs are shown separately. The Army prefers that small businesses complete the Cost Volume form on the DoD Submission site, versus submitting within the body of the uploaded proposal. The total cost should match the amount on the cover pages.

6. Requirement for Army Accounting for Contract Services, otherwise known as CMRA reporting is included in the Cost Volume (offerors are instructed to include an estimate for the cost of complying with CMRA).

7. If applicable, the Bio Hazard Material level has been identified in the Technical Volume.

8. If applicable, plan for research involving animal or human subjects, or requiring access to government resources of any kind.

9. The Phase I Proposal describes the "vision" or "end-state" of the research and the most likely strategy or path for transition of the SBIR project from research to an operational capability that satisfies one or more Army operational or technical requirements in a new or existing system, larger research program, or as a stand-alone product or service.

10. If applicable, Foreign Nationals are identified in the proposal. An employee must have an H-1B Visa to work on a DoD contract.

Army SBIR 13.1 Topic Index

A13-047	Novel Textile for Use on Low Cost Parachutes Employing Trigger Technology to Rapidly Degrade
A13-048	Non-toxic Insect-resistant Textiles for Military Clothing and Equipment
A13-049	Innovative Technologies for Miniaturized Affordable Battlefield Hardened Proximity Sensor
A13-050	Miniature Actuator Controls for 40mm Guided and Surveillance Projectiles
A13-051	Intelligent Charge Control System w/Anti-Idle to Minimize Fuel Consumption
A13-052	Modeling of Complex Environment for Unmanned Ground Vehicles Performance Evaluations
A13-053	High Bandwidth, Compact, Wireless, Millimeter Wave Intra-Missile Datalink
A13-054	Advanced Warhead Design
A13-055	Advanced Waveform Design and Signal Processing
A13-056	Urban Computer Generated Forces (CGF) Models
A13-057	Tactical Engagement Simulation System (TESS) Improved Laser Encoding and Decoding
A13-058	Non-Lethal Munitions for Defeating Improvised Explosive Devices (IEDs)
A13-059	Innovative Technology for Secure Cloud Computing
A13-060	Portable Fuel Analyzer
A13-061	Develop Efficient/Leak Proof M1 Abrams Plenum Seal
A13-062	Stand Alone Sensor for Air Bag and Restraint System Activation in An Underbody Blast Event
A13-063	Dual-Function 3D Fiber-Reinforced Transparent Material for Ballistic Protection and Shock Attenuation
A13-064	Hands Free Automatic Coupling Restraint System
A13-065	Encapsulated Air Energy Absorbing Flooring
A13-066	Supplemental External Expendable Radiator (SEER)
A13-067	Fuel Efficient Military Tire
A13-068	Advanced Human Robot Interaction to create Human-Robot Teams
A13-069	Friction Material (brake pads) for Metal Matrix Drums

Army SBIR 13.1 Topic Descriptions

A13-001 TITLE: Rear Hemisphere Tail-Rotor Obstacle Avoidance for Unmanned & Manned Rotorcraft

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

OBJECTIVE: Develop a low-cost approach for unmanned (and manned) vertical take-off & landing (VTOL) cargo and utility aircraft to autonomously detect and avoid obstacles in the rear hemisphere while conducting low-level maneuvers during the pick-up and delivery of supplies.

DESCRIPTION: Manned and unmanned VTOL rotorcraft maneuvering in low-level flight, take-offs and landing, and in confined landing zones (LZ) often lack situational awareness of obstacles in the rear hemisphere of the aircraft, especially at night and in degraded visual environments (DVE). Aircraft are typically equipped with forward and down-ward looking sensors, but lack full 360-degree coverage to detect and alert the crew and aircraft of obstacles as the aircraft is maneuvered in LZs and nap-of-the-earth (NOE) flight. The objective is to provide the aircrews and remote operators with sufficient warning to avoid obstacles in the rear hemisphere of the aircraft during turns and rearward maneuvers (within threshold 25-ft and objective 50-ft radius of main and tail rotor tips) and to provide an automated "stop" of the maneuver to the aircraft flight controls of immediate threat obstacles. For unmanned rotorcraft, the objective system should be capable of providing automated commands to the UAS' flight controls to stop and/or maneuver to avoid the obstacle.

PHASE I: Determine the technical feasibility and operational suitability of using low-cost, off-the-shelf sensors/detectors (e.g. small RF used in automotive back-up and parking systems) to prevent obstacle tail strikes by unmanned (and manned) cargo and utility rotorcraft. The technical approach should provide at a minimum sufficient warning to the operator of obstacles 25-50 feet from the tail rotor, tailboom and rear half of the main rotor disk, such that the aircraft is not inadvertently maneuvered into the obstacle. For future unmanned systems the concept is to provide suitable cuing for the UAS to autonomously avoid obstacles in the rear hemisphere while maneuvering into or out of a pick-up or drop zone. The objective interface for this control is the Obstacle Field Navigation (OFN) system developed by the US Army AMRDEC's Aeroflightdynamics Directorate. The study should include: a problem analysis to define sensor requirements; sensor design concept(s)(frequency band, range, mechanically steered or solid state, performance in obscurants/dust, signature, etc); sensor data fusion and database considerations; potential algorithm for predicting probability of collision with stationary or moving obstacles; concept for cockpit alerting mechanism (display, stick shaker, audible annunciation, etc.); potential algorithm for avoiding obstacles autonomously (e.g. US Army Aeroflightdynamics Directorate's (AFDD) RiskMinOFN); concept for integration with existing platform avionics; and airworthiness qualification plan. The study should also include a plan for any further required development, and life-cycle cost estimates. Deliverable is the feasibility study as described above.

PHASE II: Develop the best technical and operational approach from Phase I, and determine the quantity and location of sensors/detectors to provide 180-degree rear hemisphere coverage to detect and warn of obstacles 25-50 feet from the tailrotor and rear half of the main rotor disk. This phase should include: sensor design; sensor data fusion and database; algorithm for predicting probability of collision with stationary or moving obstacles; cockpit alerting mechanism (display, stick shaker, audible annunciation, etc.); algorithm for avoiding obstacles autonomously (e.g. AFDD's RiskMinOFN); and integration with existing platform avionics. Demonstrate the concept using off-the-shelf and/or prototype hardware installed on an existing unmanned VTOL aircraft. The system should be able to operate in a degraded visual environment (DVE) and provide audio and visual cues/warning of obstacles within 25-50 feet to the ground control station (GCS) operator and digital cues via OFN to the flight control system for a UAS to autonomously detect and avoid any obstacle in the rear hemisphere. A detailed project plan and test plan should be developed for integration and demonstration of the hardware and software. Hardware and software must be certified as airworthy for experimental purposes, and proper certification obtained from the FAA for UAS experimental testing. Objective is to demonstrate a TRL 6 suitable for transition to a PM for final development and acquisition. Deliverables include the prototype hardware and software, technical data, test results, and final project report.

PHASE III: Develop a flight qualified, airworthy prototype design suitable for installation on any specified VTOL aircraft. Design, fabricate, acquire and integrate hardware to be installed and tested on the VTOL aircraft. Demonstrate operational suitability, reliability, and safety of the prototype to adequately demonstrate a TRL 8 for acquisition. The objective transition is to future cargo/utility UAS and optionally-piloted vehicles (OPV) to enable safe, autonomous approach, land and take-off from confined landing areas, by autonomously detecting, reacting to and avoiding obstacles as they maneuvers in the landing area. Commercial applications would include commercial UAS and commercial helicopters, especially those performing logistical services, transmission line and pipeline monitoring services, cargo delivery, emergency medical services and other rotorcraft that require the capability to operate and land in urban areas or confined sites with complex terrain and unknown obstacles.

REFERENCES: Public Domain:
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KEYWORDS: VTOL, UAS, Obstacle Avoidance, DVE Operations, Tailrotor Strikes, VTOL Cargo Operations, VTOL Utility Operations, electronic bumpers

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A13-002 TITLE: Durable, CMAS resistant, thermal/environmental barrier coatings for metallic and CMC hot section components of gas turbine engines

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Aviation

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and validate durable, Calcia-Magnesia-Alumina-Silicate (CMAS) resistant thermal/environmental barrier coatings for metallic and CMC hot section components of turbine engines

DESCRIPTION: Gas turbine metallic combustor liner walls, along with turbine blades, vanes and shrouds are typically coated with an intermediate bond coat and a porous, ceramic-based thermal barrier coating (TBC) system to enable effective high temperature operation. Similarly, with the development of advance ceramic matrix composite (CMC) materials to replace metallic versions of these components, environmental barrier coatings (EBCs) are used in place of the TBCs for protection against temperature/moisture-induced degradation leading to spallation. Gas turbines engines that ingest sand are subject to the accumulation of deposits of Calcia-Magnesia-Alumina-Silicate (CMAS) on the TBC surfaces. The CMAS deposits are viscous, or possibly become molten, at the high combustor temperatures (>2100F). The high temperatures provide the potential for the CMAS deposits to wick into the TBC/EBC. In the case of conventional yittria-stabilized zirconia TBCs, the coating structure is columnar, which allows the CMAS material to wick between the columns. Upon cooling and subsequent hot-cold cycles, the CMAS-filled TBC/EBC is unable to handle the thermal expansion mismatch between the coating and the substrate. These stresses are often relieved by TBC/EBC spallation. Therefore, there is a need to identify CMAS resistant TBC/EBC technologies. This could be accomplished by a completely different coating micro-structure that is not columnar and is resistant to CMAS or by adding a protective layer to more conventional TBCs that stops the CMAS from getting into the columnar structure. The objective of this topic is to develop and validate durable, Calcia-Magnesia-Alumina-Silicate (CMAS) resistant thermal/environmental barrier coatings for metallic and CMC hot section components of turbine engines. The coefficient of thermal conductivity of the new TBC should be better than that of yittria-stabilized zirconia (less than 2 W/mK). The small business is encouraged to work with and establish a clear transition path with a turbine engine manufacturer.

PHASE I: Assess the feasibility of promising CMAS resistant thermal/environmental barrier coatings in the presence of CMAS. TBC coated metallic or EBC coated CMC specimens will be thermal cyclic tested at greater than 2100F with the presence of CMAS on the surface to evaluate the relative durability performance.

PHASE II: Apply CMAS resistant TBC or EBC technology to high (>2100F) temperature engine component(s) for evaluation in a full-scale cyclic endurance test with sand ingestion of the appropriate constituents to promote CMAS.

PHASE III: The optimized coating technology shall be applied to hot section component(s) for full engine test validation to TRL 6. Validation will include a sand test demonstration with appropriate cyclic content.

DUAL USE APPLICATIONS: The resulting technology will enable significantly enhanced durability of hot section components of future advanced engines with high turbine inlet temperatures operating in sandy environments. Both military and commercial aircraft applications are likely to encounter such an environment and thereby will derive benefit from this technology.

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KEYWORDS: Gas Turbine Engine, Thermal Barrier Coating, Environmental Barrier Coating, Calcia-Magnesia-Alumina-Silicate

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A13-003 TITLE: Effective Processes to Manufacture Advanced Combustion Liners with Shaped Film Cooling Holes for Gas Turbine Engines

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and validate advanced, low cost manufacturing methods such as water jet drilling or Direct Metal Laser Sintering (DMLS) to effectively manufacture advanced combustor liners with angled and shaped effusion film cooling holes.

DESCRIPTION: Small angled holes (aka effusion) are used to provide effective film cooling on gas turbine combustor liners, comprised of thermal barrier coated (TBC) sheet metal. The potential exists to shape effusion cooling holes to further improve the film cooling effectiveness. Significant reductions in liner temperatures, a direct result of improving the film cooling effectiveness, can be used to enable higher component life or enable higher power density/ fuel-efficient engines. In addition, the improved film cooling effectiveness can significantly reduce the hot-side TBC temperature such as to inhibit Calcia-magnesia-alumina-silicate (CMAS) degradation of the TBC. Current effusion holes are typically laser drilled into the liner. However, the laser drilling process does not lend itself to shaped-hole drilling. Recent developments in manufacturing technology, such as Water Jet Drilling and Direct Metal Laser Sintering, offer potential to provide an effective, low cost means of manufacturing these shaped effusion cooling holes. The objective of this topic is to develop and validate advanced, low cost manufacturing methods to effectively manufacture advanced combustor liners with angled and shaped effusion film cooling holes for application to future Army turboshaft engines. The small business is encouraged to work with and establish a clear transition path with a turbine engine manufacturer.

PHASE I: Preliminary design and evaluation of proposed process to ascertain the following: 1) feasibility of manufacturing shaped effusion holes in a combustor, 2) to characterize types of effusion hole shapes that can be effectively manufactured to maximize film cooling effectiveness and 3) to produce several coupons with a representative pattern for film cooling effectiveness assessment.

PHASE II: Proceed to fabricate parts based upon the phase I screening for assessment by combustor rig testing at relevant gas turbine condition with further refinement of the effusion shapes in order to advance the technology to a technical readiness level (TRL) of 5.

PHASE III: The optimized, shaped-hole cooling process shall be applied to a combustor for full engine test validation to TRL 6. The phase III effort will provide sufficient technology maturity to allow transition to an engine engineering, manufacturing, and development (EMD) program.

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KEYWORDS: Gas Turbine Engine, Film Cooling Effectiveness, Effusion Cooling, Combustors, Water jet Drilling, Direct Metal Laser Sintering

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A13-004 TITLE: Surface Mesh Refinement Guide Tool for Computational Fluid Dynamics Applications

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: To develop a fluid dynamics-based diagnostic tool to guide the initial creation of computationally economical surface grids for computational fluid dynamics simulations of military aircraft, missiles and associated subcomponents.

DESCRIPTION: For all of the continuous development in the field of Computational Fluid Dynamics (CFD), a certain degree of art is still required to obtain numerical solutions that can be critically judged to conform to physical reality. Much effort has been spent in creating technology that can automatically create computational meshes from geometry output by Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) software [1-4]. These methods largely define quality in terms of the conformance of the mesh to the surface, and the geometric quality of the constituent cells of the mesh. However, these qualities are not the only requirements that a surface mesh must satisfy. The mesh density of the nodes representing the surface must also be sufficient to accurately capture gradients in the flow field near the surface [5-7]. Too coarse of a mesh causes sharp gradients in the flow field to suffer from numerical diffusion, where sudden changes in fluid properties or behavior are unrealistically “smeared” [8]. Too many points, and the time and computational expense required to achieve a converged CFD solution increase geometrically, if not exponentially, to the point where solution is impractical. This balance between physical fidelity and computational expense is a problem that CFD practitioners usually must address though intuition and experience.

Current grid creation and refinement technologies require iterative CFD calculations to produce an acceptable surface mesh [9]. For complex geometries, such as those associated with military aircraft and missiles, this involves running test simulations that can require days to run on hundreds or thousands of computer processors in a modern supercomputer. For a sufficiently complex CFD model, additional time on the order of man-weeks may be required to manually refine surface meshes over geometrically complex features during successive iterations. Thus, a significant amount of time, effort and computational resources are required to complete aerodynamic analyses. For production engineering applications, time and available computational hardware may force the “acceptable” mesh to be of significantly lower quality than the optimum mesh, resulting in increased computational cost with lower solution fidelity [7].

The objective of this topic is to advance the state-of-the-art in initial surface mesh generation for CFD simulations of military aircraft and missiles of complex topography. The desired ultimate end-product would be a software tool that could use lower-order aerodynamic methods to identify regions on surfaces where surface mesh grid point density should be concentrated to capture significant features in the near flow field, while also identifying regions of benign flow where surface grid point density could be lessened to save computational expense. As most Army aircraft and missiles operate in the high Reynolds number regime, it is possible that the off-body flowfield could be assessed using inviscid methods, such as panel codes or vortex lattice methods, to estimate pressure gradients and local flow direction, while boundary layer methods could be used to estimate gradients within the boundary layer, separation bubbles and wakes. The results from this tool’s analysis could then be output in a format that could be visualized to guide CFD mesh creation and refinement.

PHASE I: Identify innovative methods to guide the initial creation of computationally economical surface grids for computational fluid dynamics simulations of military aircraft, missiles, and associated subcomponents, based upon input of triangular or quadrilateral surface tessellations of the wetted outer mold line geometry. Develop a plan to implement these methodologies into a software tool. Provide preliminary verification and validation approaches to support the activity. Identify example surface geometries and computational and experimental data sets that will be used for verification and validation of tool operation.

PHASE II: Develop a software tool implementing the methodologies identified in Phase I. Demonstrate levels of computational efficiency and accuracy improvements in aerodynamic lift, drag and moment estimation gained by using CFD surface meshes developed from guidance provided by the tool versus results obtained by grids created using current, standard practice methods.

International Traffic in Arms Regulation (ITAR) control is required.

PHASE III: If successful, the product produced from Phase II will be a tool that can guide the initial creation of computationally economical surface grids for computational fluid dynamics simulations of complete military aircraft, missiles, and wetted external components. The next, logical step for this capability would be to tightly couple the methodology with a surface grid generation tool to automate the creation of optimized meshes during the initial grid generation process.

In addition to military uses, the resulting tools would be of value to civilian CFD practitioners. The time required to create grids for aerospace CFD simulations would be reduced, while the accuracy of the computed solutions would be increased by concentrating grid density in regions of most interesting flow behavior. This would allow the CFD solutions to be used as the basis for total aircraft aerodynamic performance estimation, estimation of engine power required, and to provide aerodynamic force and moment inputs to other engineering disciplinary tools such as computational structural mechanics and dynamics analysis software packages.

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KEYWORDS: Grid generation, meshing, mesh refinement, computational fluid dynamics, computational cost, fluid mechanics, aerodynamics, boundary layer.

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A13-005 TITLE: Short Duration, High Altitude, Mixed Continuum/Non-Continuum Flowfield

TECHNOLOGY AREAS: Air Platform, Weapons

ACQUISITION PROGRAM: PEO Missiles and Space

OBJECTIVE: To develop innovative models for the basic fluid dynamic processes which describe short duration, high altitude events with mixed continuum and free molecular flow regimes.

DESCRIPTION: Computational fluid dynamic analysis of short duration, high altitude (45 to 100 km) events, propulsive and/or detonative in nature, continue to prove problematic because of the inherently unsteady and three-dimensional nature of the flows, potentially involving chemical kinetics and two-phase flow features, all within a temporally evolving heterogeneous rarefied/continuum environment. The most robust computational technology for rarefied flows is the Direct Simulation Monte Carlo (DSMC) scheme. Although the method naturally asymptotes to continuum flow, it rapidly becomes computationally intractable as the flow becomes denser. Under the continuum regime, it is more efficient to utilize the traditional Reynolds Averaged Navier Stokes (RANS) formulation. Consequently, the ideal simulation of such events involves the use of hybrid technologies which couple the rarefied and continuum flow regimes, preferably, within a unified framework.

To this end, innovative techniques are sought to produce a mixed continuum/non-continuum flowfield capability within an existing computational fluid dynamic (CFD) model suitable for treating chemically reacting two-phase, gas-particle, flows. Special consideration must be given to modeling laminar-turbulent transition, wall boundary conditions, temporal evolution, and the possible interaction with hard bodies for these mixed continuum/non-continuum flows.

PHASE I: Innovative technical approaches will be formulated in Phase I to develop a mixed continuum/non-continuum flowfield capability leading to an advanced computational fluid dynamic (CFD) model as a marketable product. These technical approaches must address the key problem areas of coupled continuum-rarefied flow modeling that is requisite for high-fidelity characterization of short duration propulsive/detonative events; namely, mixed continuum/rarefied flows; unsteady effects; chemical kinetics for describing combustion in fuel rich environments, two-phase effects, and generalized 6 degree-of-freedom hard body interactions. Sample test cases will be run and detailed in the Phase I final report to demonstrate the key capabilities of a selected method(s). A detailed roadmap for product development under Phase-II execution will also be delivered.

PHASE II: The proposed Phase I plan to develop an advanced, detailed physics-based high-fidelity simulation model or CFD code to accurately model high altitude, transient flowfields as required to support the computational fluid dynamics analyses of propulsive/detonative events will be implemented. Numerical studies will be conducted to address specific components of the new computational model as they apply to problems of interest to the Army. A full discussion of the technology along with the results of the numerical studies will be delivered with the Phase II final report.

As a final product, the advanced CFD code should be fully executable on a linux cluster computer requiring no more than 200 CPUs, 16 GB memory per node, and run times within 24 hours.

PHASE III: If successful, the end result of this Phase-I/Phase-II research effort will be a validated computational fluid dynamics model to predict short duration, high altitude events. The transition of this product will require additional testing to gauge the validity, accuracy, and applicability of the model. For military applications, this technology is directly applicable to all missile systems which operate at higher altitudes, such as interceptors and space delivery vehicles, where propulsive/detonative events, i.e. jet-interaction thrusters, are of interest. For commercial applications, this technology is directly applicable to advanced propulsion techniques for commercial applications such as high speed supersonic transports and to orbital launch systems. The most likely customer and source of Government funding for Phase-III will be those service project offices responsible for the development of missile interceptors such as the THAAD, SM-3 and GMD programs.

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KEYWORDS: computational fluid dynamics, continuum flows, free molecular flows, flow transition, RANS/DSMC, two-phase, gas-particle flow, finite-rate chemistry

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A13-006 TITLE: Afterburning Missile Base Flow Modeling and Analyses

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Missiles and Space

OBJECTIVE: To develop a validated, advanced, detailed physics-based capability to accurately model the separated flow physics immediately downstream in the base region of a propulsive supersonic/hypersonic missile.

DESCRIPTION: Missile base flow is an area that has eluded a satisfactory solution since the 1950's. This flow region contains most of the complications of aero-thermo-chemical problems including flow separation, two-phase gas/particle non-equilibrium, chemical kinetics, turbulent flow, and complex geometry. Recently, progress has been made on predictions of the basic, blunt-base, cylindrical geometry with state-of-the-art hybrid Reynolds-averaged Navier-Stokes/Large Eddy Simulation (RANS/LES) computational fluid dynamics (CFD) formulations although these predictions are still far from routine, can be computationally expensive and have been restricted to cold flows. While additional strategies might be required to resolve the turbulence in the base flow region, the validation and systematic refinement of models has been hindered by the absence of well-controlled laboratory base flow (pressure and heat transfer) data, augmented by detailed non-intrusive time-resolved flow visualization, diagnostics and in-field measurements under missile-representative hot, afterburning flow conditions.

Innovative CFD solutions techniques and benchmark experimental data are sought which can advance the state of the art for the prediction of the flow field in the base region of a supersonic/hypersonic missile flying at low altitude (turbulent flow). This predictive capability, within an existing computational fluid dynamic (CFD) model, must account for the effects of incoming boundary layer, asymmetric body flows, multi-phase effects, the exhaust of fuel rich, high-temperature chemically-reacting gases from the nozzle, vigorous afterburning in the base region and the downstream plume, as well as three-dimensional arbitrary geometry. The model shall be able to predict the flow separation processes, as well as the overall near-wake flow structure and base drag.

PHASE I: Innovative technical approaches will be formulated in Phase I leading to an advanced computational fluid dynamic (CFD) model, as a marketable product. These technical approaches must address the key problem areas of supersonic/hypersonic base flow modeling; namely, the coupled effects of incoming boundary layer, asymmetric body flows, the exhaust of high temperature fuel rich reactive gases from the nozzle, vigorous afterburning in the base region and the downstream plume, as well as three-dimensional arbitrary geometry. These formulated approaches shall be coded into an existing computational fluid dynamic model for non-equilibrium, chemically reacting multi-phase flows and preliminary validation shall be demonstrated for afterburning baseflows. These test runs will be documented in the Phase I final report along with a detailed plan for product development under Phase II.

PHASE II: The physical model formulated in Phase I will be developed and refined as necessary to produce an advanced physics-based high-fidelity simulation model or CFD code to evaluate base interaction flowfield performance over a range of flight scenarios of interest. Benchmark experimental data will be required for model validation for baseflow interaction flow fields representing systematic variations of flight Mach ranging from ~ 2 to 4. Though not strictly required, any opportunities to acquire such high quality axisymmetric, supersonic experimental base flow measurements under representative high-temperature afterburning exhaust conditions, would be beneficial.

As a final product, the advanced CFD code should be fully executable on a linux cluster computer requiring no more than 200 CPUs, 16 GB memory per node, and run times within 24 hours.

PHASE III: If successful, the end result of this Phase I/Phase II research effort will be a validated predictive model for the analysis of supersonic/hypersonic, low altitude, missile base flows. The transition of this product (a validated research tool) to an operational capability will require additional upgrades of the software tool set for a user friendly environment along with the concurrent development of application specific data bases to include the required input parameters such as missile geometries, solid rocket motor properties, and performance parameters.

For military applications, this technology is directly applicable to all rocket propulsion missile systems. The most likely customer and source of Government funding for Phase III will be those service project offices responsible for the development of advanced missile systems such as the SM-3, THAAD, and PAC-3 programs.

For commercial applications, this technology is directly applicable to all commercial launch systems such as the NASA Aries, and the Delta and Atlas families.

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KEYWORDS: baseflow, computational fluid dynamics, finite rate chemistry, combustion, propulsion, aerodynamics, hypersonics

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A13-007 TITLE: Automated trace gas molecular analyzer using rotational spectroscopy

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Missiles and Space

OBJECTIVE: Construct an automated molecular spectrometer operating in the mm/submm wavelength spectral region that can analyze a low-pressure gas mixture and identify the composition and concentration of its constituents.

DESCRIPTION: There is a long-standing and growing need to measure the composition and concentration of mixtures of unknown gases. Among the many examples that may be cited, of principal interest to AMRDEC is the need to monitor the health and degradation of rapidly aged missile propellant formulations by measuring the composition and concentration of out-gassed decomposition by-products. Other examples of interest to AMRDEC include the monitoring of vapor from toxic industrial chemicals (TICs) [1] and the analysis of the molecular composition and concentration of rocket exhaust.

Low-pressure gas phase molecular rotational spectroscopy in the millimeter/submillimeter (mm/submm) wavelength, terahertz frequency region has been well established for more than 60 years.[2],[3] Known to produce spectra of polar molecules with incredible recognition specificity (essentially no false positives) and sensitivity (at the parts per trillion level), this technique has been limited to laboratory scale application because of the immaturity of the source and detector technology. As these technologies mature, the opportunity exists to develop a spectrometer as easy to use as Fourier transform infrared (FTIR) spectrometers but with much greater recognition specificity and sensitivity.[4],[5],[6]

For this instrument, it may be assumed that the gas, which may have been pre-concentrated, is provided in a sample container whose volume is <1 liter with pressures of <1 Torr after obscuring atmospheric gases (N2, O2, Ar) have been removed through some combination of pristine collection, cryopumping, and/or release from an appropriate sorbent. A portion of this gas sample will be measured by the spectrometer at sufficiently low pressure that line center frequencies and strengths may be measured precisely and quantitatively (i.e. lines are Doppler-broadened with linewidths of ~1 MHz). The remaining challenges facing the construction of such a diagnostic instrument are the need to (1) measure and (2) analyze the spectra reliably in order to identify the constituent gas composition and quantify their respective concentrations. It must be assumed that the constituent gases are unknown prior to measurement. Therefore, it is not sufficient that the spectrometer only measure and identify lines in its library, it must measure all lines over its scan region, identify lines not in its library, and ascertain whether these indicate the presence of additional unknown species. By no means must the spectrometer scan the entire mm/submm wavelength spectral region, but must scan far enough with enough resolution that molecules of military interest (including the TICs with permanent dipole moments) or variants thereof may be detected, analyzed, recognized, and quantified with confidence.

To build such an instrument, two advances are needed. First, a high-resolution spectrometer operating in the mm/submm wavelength region must be constructed that can perform sufficiently broad spectroscopic sweeps with sufficiently high signal-to-noise ratios to achieve detection thresholds well below 1 ppb. Second, a sophisticated analysis algorithm must be developed that uses a library of previously measured spectral features (including spectra from naturally abundant isotopomers and thermally populated vibrational levels) to identify the composition and concentration of constituent molecular gases. The algorithm must also provide a spectroscopic listing of unassigned measured lines that will require subsequent analysis to identify. This analytical tool must be expandable as new data becomes available, preferably by measurements performed with the spectrometer and subsequently “learned” through a calibrated library-building feature that may also be used to populate the initial library. The user output will be a simple table that displays the measured gases and their concentrations, plus an auxiliary table that lists the unassigned lines.

PHASE I: Design a spectrometer capable of ascertaining the composition and concentration of a low pressure gas mixture using measured and/or calculated molecular rotational spectra in the mm/submm wavelength region. It may be assumed that the user has previously “purified” the gas by removing ambient atmospheric gases N2, O2, and Ar and that the spectrometer will be able to measure the pressure of the fraction of the sample introduced into the diagnostic cell. The deliverable at the end of Phase I is the completed design of the spectrometer and the demonstration of a working gas analysis algorithm to convert measured spectra into quantitative estimates of constituent composition and concentration with false recognition probability <10^-6 and partial pressure sensitivity <1 mTorr, respectively. The spectral region covered, the anticipated molecular library, the anticipated acquisition time, the anticipated analysis time, and the detection threshold must all be estimated.

PHASE II: Based on the Phase I design, construct and deliver to AMRDEC a spectrometer capable of ascertaining the composition and concentration of a low pressure gas mixture using measured molecular rotational spectra in the mm/submm wavelength region. The deliverable at the end of Phase II is a working spectrometer and gas analysis algorithm that provides quantitative estimates of constituent composition and concentration with false recognition probability <10^-6 and sensitivity <1 ppb, respectively. As part of the gas analysis algorithm, a large and expandable library of spectra must be provided as well as a means for adding new spectra through measurements in the spectrometer, predictions from on-line databases, and/or calculations based on published rotational constants.

PHASE III: An improved version of this spectrometer with an automated gas sampling/purifying stage and low unit cost would find tremendous military and civilian markets in areas that include non-destructive test, treaty verification, early warning sentinel for toxic gas release, chemical health monitoring, chemical quantitative analysis, medical screening, detection of illicit drug production, location of hazardous waste sites, atmospheric monitoring of plant emissions, and border/port patrol, among many others. Therefore, the goal of a Phase III effort is to reduce size, weight, power, and cost while increasing the instrument’s autonomy and the size of its library to cover an ever-increasing realm of applications.

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KEYWORDS: Molecular spectroscopy, Terahertz spectroscopy, Millimeter-wave spectroscopy, Trace gas analysis,

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A13-008 TITLE: All-solid-state Hybrid Energy Storage System (Battery-Ultracapacitor)

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Missiles and Space

OBJECTIVE: Current technologies tend to limit capabilities of energy storage devices either to high energy storage or high power delivery. The objective is to develop all-solid-state flexible energy storage devices with both high energy and high power densities for various battlefield applications ranging from miniaturized sensors, communication devices to missiles.

DESCRIPTION: Power requirements for various battlefield applications such as missiles, sensors, communication systems, night-vision devices, etc. vary from high energy storage to high power delivery capabilities. High energy densities of batteries are favorable in powering devices for extended periods in a wide variety of duty cycles to sustain their operation throughout the mission lifetime [1,2]. However, batteries are capable of delivering only limited power upon discharge. Ultracapacitors based on electrochemical double-layer capacitance possess the ability to deliver more specific power but store less specific energy than batteries [3,4]. They are used in many applications such as quick reaction systems including munitions, power electronics, etc., where a sudden surge of power is required. However, the performance demands of such applications cannot be fully met because of the low energy density of ultracapacitors.

The main objective of this solicitation is to investigate novel electro-chemical solutions to simultaneously optimize energy and power density of energy storage systems. The current-state-of-the-art of such hybrid systems consisting of redox and double-layer components is still unable to meet the energy and power demands of the warfighter [5,6].

This solicitation is aimed at achieving energy densities > 100 Wh/kg in all-solid-state energy storage systems while maintaining their power densities above 1 kW/kg. Furthermore, specific characteristics of ultracapacitors such as fast charge/discharge capability, high cycleability, and low equivalent series resistance should be preserved [3]. Solid components are preferable over the liquid phase materials to avoid any spillage during use under extreme conditions in battlefield environment. The storage media should be conformal and flexible for the widest possible range of applications [7,8].

PHASE I: Conduct a feasibility electro-chemical analysis of the integration of battery and on electrochemical double-layer technologies with all-solid-state components. The hybrid system should include the attributes of batteries allowing high energy density, and the characteristics of ultracapacitors of rapid charge/discharge rates in order to optimize the energy and power densities to achieve the target values stated above.

PHASE II: Design and fabricate a prototype hybrid energy storage system. All appropriate electro-chemical characteristics, engineering testing and validation of the performance of the prototype system should be performed. Parameters to be tested should include specific capacitance, maximum operating voltage, maximum power and energy density, cycle stability, chemical and thermal stability, equivalent series resistance and leakage current. A working prototype should be submitted to Army for evaluation.

PHASE III: Flexible hybrid energy storage systems can be packaged in a variety of form factors, and hence, they have dual use for both military and civilian applications. They can be used as power sources for quick reaction munitions, soldier-portable systems, distributed sensor systems, etc. in the battlefield. The environmental requirements for military power sources may include their use at extreme hot and cold temperatures, exposure to dust, wind, snow and high levels of shock and vibration both in use and during transportation. Among numerous civilian applications, electric and hybrid vehicle applications are considered to be the most applicable with this technology.

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KEYWORDS: energy storage, specific energy, specific power, battery, ultracapacitor, supercapacitor, flexible, all-solid-state, electrochemical double-layer.

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A13-009 TITLE: Super-black Metallic Surfaces

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: PEO Ammunition

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Design, develop, prototype, and demonstrate an antireflective coating or surface treatment process for metals that achieves light absorption of at least 95 percent (with a goal of 99 percent) in the ultraviolet, visible, infrared, and far-infrared regions. In addition to high broadband absorption, this coating or process should permit multiple surface colors on the treated material and improve the heat transfer properties of the material.

DESCRIPTION: New surface structuring processes and nanodeposition technologies have demonstrated superior antireflective properties and thermal characteristics that improve heat dissipation. They have also demonstrated hydrophobic (water repellent) anticorrosive properties and hydrophilic (water absorbent) evaporative cooling properties. Although the primary aim of this topic is to create an antireflective coating, these other attributes are highly desirable. This technology has been demonstrated in small volumes, and this SBIR effort will determine if large scale applications are possible.

PHASE I: Research, develop, and experiment with methods to reduce and alter the spectrum of reflected light from steel and lightweight metal alloys. Verify through lab testing that the processed surfaces reduce and alter the amount of broadband reflected light off of these materials in the ultraviolet, visible, and infrared wavelengths. Verify that the magnitude and duration of heat transfer for the treated materials have been improved. Determine if the candidate process is also applicable to optical glass surfaces.

PHASE II: Evolve the process identified in phase I to treat non-planar surfaces. Determine the durability of the surface and whether it will be able to survive in a military environment (MIL-STD-810). Verify through operational testing the improved performance of treated surfaces.

PHASE III: Optimize the production process established in Phase II. Create a partnership with industry to commercialize the technology. The coating or process developed under this effort should result in applications across all branches of the armed forces. The transition of this technology to industry will improve heat transfer in electronics, reduce stray light in optics and optical test equipment, and improve electro-optic and camera performance if application temperature versatility can be achieved.

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KEYWORDS: Coatings, anti-reflective, heat sink, colorizing metal, laser blackening

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A13-010 TITLE: Development of Ductile, Bulk Tungsten for Next Generation Munitions and Warheads

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Ammunition

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: To increase the ductility of bulk tungsten and develop a scalable manufacturing method for production.

DESCRIPTION: Tungsten is an attractive material for military use due to its very high density (19.3 g/cc), melting point (3410C), strength, corrosion resistance, and benign environmental impact. It is mainly limited in use due to its brittleness (low ductility) and subsequently high ductile-to-brittle transition temperature (DBTT) range. The temperature where tungsten usually transitions from brittle behavior to ductile behavior is between 280C and 330C. The reason for the brittleness of tungsten at room temperature can be largely attributed to grain size, grain boundaries, and impurities.

Past efforts to increase the ductility of tungsten have focused on alloying, grain refinement, extreme working, area reductions (dislocation densities), impurity reductions, and heat treatments. For example, traditional alloying of tungsten with nickel, iron, and cobalt can produce a strong ductile material, but at the sacrifice of density. Ductile tungsten currently exists in wire form through working and area reduction (i.e. filaments), but this does not lend itself practically to military applications where large bulk sizes are needed.

One of the most successful and significant methods of lowering the DBTT has been by alloying tungsten with Rhenium. However, the high cost of Rhenium makes this method non-ideal. Alternative low cost alloying additions are needed, and the basic mechanisms behind why Rhenium imparts ductility need to be fully explored. Once the W-Re system is understood, materials and processing techniques can be exploited to develop low cost, ductile tungsten that is simple to process by conventional equipment, near the density of pure tungsten, and in sizes which are practical for munitions use.

Increasing the quasi-static and high strain rate ductility of tungsten will have multiple military payoffs, allowing for more usage opportunities as well as enhanced performance in legacy applications. Such payoffs include:

1) An alternate EFP material to tantalum at a lower cost with increased performance. Tungsten provides a 2.6 g/cc density increase over tantalum.
2) An alternate shape charge liner material to copper and molybdenum with increased performance. Tungsten provides a 9.02 g/cc density increase over molybdenum and 10.36 g/cc over copper.
3) Alternate material to depleted uranium in kinetic energy penetrators. DU is currently the material of choice regarding KE penetrators, but due to political pressures, environmental, and health concerns, an alternate material must be developed. Developing ductile tungsten will enhance launch survivability.
4) Enhanced performance in small caliber applications against targets at obliquity. Current rounds have ballistic issues upon target impact at unspecified angles.
5) More complex geometries for warhead packages. Machining and forming of less brittle tungsten will allow for more a more widespread integration as a warhead item in legacy munitions.
6) Logistics optimization through the use of a single material in multiple munitions packages.

PHASE I: The objective of Phase I is to develop a synthesis and processing technology to fabricate low cost (Rhenium free), bulk, ductile tungsten. Metrics to be met are density = 18.0 g/cc, diameter = 1” & length 4” to 6”, 2 deliverable rods, and an elongation = 5% at room temperature. Extensive microstructural, compositional, and mechanical characterization, as well as quasi-static mechanical testing shall be performed as per the applicable ASTM standards. However, high strain rate ductility is the ultimate goal.

PHASE II: The objective of Phase II is to further refine and optimize synthesis and processing technology & materials properties to meet Phase II metrics of density =18.0 g/cc, diameter = 4” & length 8” to 10”, 5 deliverable rods, and an elongation =10% at room temperature. Characterization shall be performed as outlined in Phase I.

PHASE III: The objective of Phase III is to transition the fabrication technology to produce large quantities of optimized ductile tungsten from Phase II. The metrics to be met are a price increase no greater than 10% over the cost of commercial tungsten. Included military applications that will benefit from the technology developed are shape charge liners, explosively formed penetrators, kinetic energy penetrators, and small caliber munitions. Commercially, ductile tungsten can be utilized in mining, aerospace, and counterweight applications.

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KEYWORDS: Tungsten, Ductile, Ductility, Lethality, Penetrator, Shape Charge, Tantalum, Molybdenum, EFP, Shear, High Density, Liner, DU, Launch Survivability, Warhead, Munition.

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A13-011 TITLE: Advanced hybrid graphitic materials for enhanced energetic applications

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Ammunition

OBJECTIVE: To develop materials with superior energetic properties than the current state-of-the-art by utilizing advanced hybrid graphitic materials known for their remarkably high thermal conductivities.

DESCRIPTION: Due to their remarkable mechanical, electrical and thermal properties, highly ordered graphitic systems such as graphene and its derivatives have generated substantial interest and investment from the academic, commercial and military R&D communities. Graphene and its derivatives offer the promise to enable the next generation of military technology from flexible body armor to tunable transistor devices and recent advancements in propellant research have demonstrated these materials' potential for enhanced energetic applications. It has been demonstrated in the literature that functionalized graphene sheets (FGS) in a colloidal suspension mixed with fuels such as nitromethane (NM) have resulted in enhanced burning rates in parallel with reduced ignition delays.

PHASE I: The objective of phase I will be the incorporation of graphene (pristine, doped, functionalized) into a double-base (containing nitrocellulose and nitroglycerine) propellant formulation. All methods of incorporation in and dispersion within the propellant formulation may be considered and a material analysis will be performed to determine that the graphene maintains its highly ordered configuration within the propellant with minimal agglomeration. The purpose of this effort shall improve or maintain basic sensitivity in terms of impact, friction and electrostatic discharge against the graphite propellant formulation.

PHASE II: In phase II it will be demonstrated that the process for producing the graphene propellant formulation will be scalable and that the material shall achieve a 10% (threshold) or 20% (objective) increase in performance over a graphite containing propellant in either the closed-bomb or strand-burner test. One kilogram of material shall be delivered to ARDEC for testing. The process of graphene dispersion into the double-base propellant shall be transferred to ARDEC for prototyping and pilot-plant work.

PHASE III: In phase III the technology shall be transferred to a prime contractor or the contractor shall demonstrate scale up and manufacturing capability. The graphene propellant formulations shall be integrated into military weapons platforms identified in governmental testing performed in phase II. Extension of the work to the private sector will have commercial applications for the automotive, space and mining industries.

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KEYWORDS: Keywords: graphene, nanoparticle, propellant, insensitivity, burning rate, colloid, functionalization

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A13-012 TITLE: Novel Control Technologies for Guidance of High-Spin Stabilized Munitions

TECHNOLOGY AREAS: Battlespace

ACQUISITION PROGRAM: PEO Ammunition

OBJECTIVE: Develop novel technologies for control systems for flight trajectory correction of guided spinning munitions. The technologies being sought must be applicable to the integration of controls for performance enhancements of munition trajectories with low (around 20 Hz) as well as high (200Hz or higher) spin rates, be low cost to produce and consume minimal electrical energy.

DESCRIPTION: Different technologies and related components have been developed or are under development for guidance and control of guided munitions, including gun-fired munitions and mortars. Many of these devices have been developed based on technologies used in missile and aircraft, and are difficult or impractical to implement on gun-fired projectiles and mortars with their very different guidance, control and stability characteristics and operational requirements. Other technologies developed for munitions applications are suitable for non-spinning rounds or for rounds with very low spinning rates. Current guidance and control technologies and those under development are not effective for flight trajectory correction of high-spin guided munitions. Such spin stabilized rounds may have spinning rates of 200 Hz or higher, which pose numerous challenging sensing, actuation and control force generation and control algorithm and processing issues that need to be effectively addressed using innovative approaches.

The focus of this SBIR project is the development of novel, low-cost and low power consumption technologies for flight trajectory control of high-spin rounds that occupy small munitions volume. The proposed novel technologies must be applicable to direct fire/intercept munitions with setback accelerations in the range of hundreds of G's to over 50 KGs; and spin rates of 20Hz to 200 Hz or higher, providing impulse in the range of 10N-sec to 140 N-sec for up to 2 milliseconds. The proposed technologies must be scalable to medium as well as large caliber munitions. The proposal must consider the cost and manufacturing issues. Reliability is also of much concern due to the harsh launch environment and since the rounds need to have a shelf life of up to 20 years and could generally be stored at temperatures of sometimes in the range of –65 to 165 degrees F with a shelf life of up to 20 years.

PHASE I: Develop novel technologies for flight trajectory correction of guided spinning munitions based on the proposed concepts for use in the next generation of guided munitions. Proposer must develop analytical and/or quantitatively show models to study the feasibility of each concept and calculate their performance and present a detailed report of the findings that show feasibility and potential to advance for further development.

PHASE II: Develop prototype of the flight trajectory correction system for a selected spinning round based on the optimum design arrived at from the project modeling and simulation efforts. Perform laboratory tests on instrumented test-bed developed for this purpose to validate the performance of the system and its various components. Perform wind tunnel tests to validate the performance in near to actual flight conditions. Design and fabricate a final prototype based on the results of the laboratory and wind tunnel tests.

PHASE III: The end vision of this SBIR effort is the insertion of the developed novel flight trajectory correction technology for extending the range of hypervelocity munitions, direct fire and intercepting munitions. A second insertion would be for course correction and terminal guidance for mortar, artillery and fuzing systems. PM MAS (Program Manager Maneuver Ammunition Systems) and PM CAS (Program Manager Combat Ammunition Systems - Mortar).

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KEYWORDS: trajectory correction, guided munitions, real-time maneuver, high-G survivability, Guidance and Control, precision munitions

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A13-013 TITLE: Low Energy Consumption Compact Control Actuation Systems for Precision Guided Artillery and Mortar Munitions

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Ammunition

OBJECTIVE: Develop innovative control actuation systems (CAS) that deliver required flight maneuver and attitude control forces at significantly lower energy consumption levels compared with current electro-mechanical CAS systems utilized in precision guided artillery, mortar munitions and long range munitions.

DESCRIPTION: Electro-mechanical control actuation systems utilized in precision guided artillery and mortar munitions typically require between 4,000 joules to 8,000 joules of on-board energy to deliver the maneuver and attitude control necessary in achieving required precision for the duration of flight from muzzle exit to target. The capability to deliver the control authority needed at reduced energy consumption provides significant advantages including increased volume for delivered payload, reduced signature, improved safety and reliability, and lower unit cost. Proposed solutions must be compatible with common guidance and navigation control algorithms and command structure, and should operate in both closed-loop and open-loop modes. The proposed novel technologies must be applicable to medium and to long range munitions with setback accelerations in the range of 15KGs to 30KGs or higher, providing impulse in the range of 600 N-sec to 900 N-sec averaged over 30 seconds to 40 seconds and minimum lateral force of 100N to 200N, and long range munitions applications requiring over 6000 N-sec averaged over 50 seconds with minimum lateral force of 800N. Additionally, successful approaches must conform to geometric restrictions and interface requirements associated with the initialization, loading, launch, and flight phases of the munition. In all cases, the proposed solutions must be capable of reliable operation after exposure to environmental conditions including cold and hot temperature extremes in the range of -65 degree F to 165 degree F, shock and vibration, the elements (e.g. dust, salt water spray, rain, humidity, etc.), hot gun gases, high gun launch accelerations in both axial and lateral directions, tip-off loads at muzzle exit, and potential aero-thermal heating under some conditions. Proposed solutions must also meet 20 year shelf life requirements. Proposed solutions should address medium to long range munitions actuations requirements and require no greater volume or envelope than current CAS systems, with an objective to reduce occupied volume compared with existing systems.

PHASE I: Develop novel technologies for flight trajectory correction of guided and smart munitions for artillery and mortar munitions. The phase I effort should include studies of the impact of affordable precision on the fires mission for smart artillery and mortar munitions. Present analytical and feasibility studies which would significantly and economically enhance the accuracy and/or performance of existing artillery projectiles both improving efficiency and decreasing the combat logistical burden. Develop analytical and/or numerical models to study the feasibility of each concept and calculate their performance.

PHASE II: Develop prototypes to demonstrate flight trajectory correction control technologies for precision guided and smart munitions.

Perform laboratory tests on instrumented test-bed developed for this purpose to validate the performance of the system and its various components. Perform wind tunnel tests to validate the performance in near to actual flight conditions. Design and fabricate a final prototype based on the results of the laboratory and wind tunnel tests.

PHASE III: The end vision of this SBIR effort is the insertion of the developed novel flight trajectory correction technology for artillery and smart mortars. A second insertion would be for course correction and terminal guidance for mortar, artillery and fuzing systems. PM MAS (Program Manager Maneuver Ammunition Systems) and PM CAS (Program Manager Combat Ammunition Systems - Mortar).

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KEYWORDS: flight maneuver and attitude control, precision guided artillery and mortar munitions, Electro-mechanical control actuation, control authority

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A13-014 TITLE: Tactical Wireless Ground Sensor Network Deployment and Maintenance System

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: The objective is to develop a portable system for deployment planning, real-time monitoring and maintenance of tactical wireless ground sensor networks.

DESCRIPTION: Wireless ground sensor networks provide warfighter with superior situational awareness and valuable intelligence that are critical to mission success. However, operation of wireless ground sensor networks are often hindered by factors such as limited energy budget, challenging near ground level radio signal propagation and unpredictable bursty data traffic pattern. The multi-hop radio technology used to improve energy efficiency and to extend the range of wireless ground sensor networks introduces additional configuration and operational complexity beyond the conventional point-to-point networks. Deployment and maintenance of wireless ground sensor networks currently require significant effort and expertise on radio and network technology. Repeated trial-and-errors are often needed to place sensors and relay nodes to form a robust wireless ground sensor network to meet the mission requirement; a task that is especially difficult in unfamiliar or unfriendly terrain. Since operating condition and data traffic pattern often change during a mission, the ability to monitor and analyze the network traffic and to provide adjustment to the network configuration in real-time is crucial to maintaining the required level of network performance throughout the mission. The aim of this project is to seek an innovative solution to lessen the burden on the warfighter while deploying and operating wireless ground sensor networks so they can focus on the mission instead of the network.

Proposed approach should yield a portable system that is capable of providing accurate output in real-time to aid in deploying wireless ground sensor networks that optimally meet mission requirements (e.g., area of coverage, speed, latency, and energy expenditure) and to maintain optimal operation as mission condition changes. The resulting system can be a dedicated device, a software application running on commercially available off-the-shelf (COTS) hardware, or a combination of dedicated and/or COTS hardware and software. The preferred approach is one that requires minimal wireless network expertise and interaction from the end users in the fields.

PHASE I: Perform investigation on the feasibility of a portable system for deployment planning and real-time operation monitoring of tactical wireless ground sensor networks that provides high level of accuracy while requiring minimal input from the users. Develop a preliminary design and demonstrate an approach that would address the technical challenges of deploying and maintaining optimal operation of tactical wireless ground sensor networks. Documentation for Phase I shall include a detailed description of key technical and implementation challenges and how the challenges can be met by the proposed solution.

PHASE II: Develop a prototype system to demonstrate the functionality of a portable deployment planning tool for tactical wireless ground sensor networks in a relevant test environment to validate the performance and accuracy of the system. The prototype shall also demonstrate at least basic wireless sensor network traffic monitoring and analysis capability.

PHASE III: Develop a complete solution to include all functions of a portable tactical wireless ground sensor networks deployment planning and operational monitoring system. Continue improvement in system performance, accuracy and usability over a wide range of operating conditions. Explore extending the technology to other challenging defense and security applications such as ad hoc robot wireless networks, Unmanned Ground Vehicles (UGV) wireless sensor networks, first responder wireless sensor networks, etc.

Commercialization Potential: Wireless sensor networks technology is also an active area of search and development in the private sector, e.g., IEEE 802.15.4 standard, WirelessHart, and ZigBee. A wide variety of applications such as industrial monitoring, health care monitoring, and asset management have been proposed and are being developed. These applications often have to operate in challenging environment where RF propagation characteristic can be difficult to predict, e.g., complex metallic structures in a refinery, and where the end users generally have little to no knowledge of wireless networks. Innovative solution for a cost effective, reliable and user friendly wireless sensor networks deployment and monitor system will benefit both commercial and defense customers to ease the deployment, to optimize the operation, and to fully realize the benefits of their sensor networks.

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KEYWORDS: Wireless sensor network, multi-hop mesh network, radio signal propagation, network traffic monitor

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A13-015 TITLE: Skin Attached Traumatic Brain Injury Sensing System

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Proposals are sought to develop a flexible, conformal, skin-attach electronic platform for wearable sensors, with the goal of attaching sensors anywhere on the body to monitor the environment and/or physiological parameters of the wearer. The platform should include microprocessor with simple data analysis algorithms, data storage, power supply, and wireless Radio Frequency communication, along with a method for incorporating digital sensors both mechanically and electronically into the system.

DESCRIPTION: Over the past 5 years the Army and the Department of Defense have been developing sensor systems for detection of impact and blast events with potential for causing traumatic brain injury (TBI). Most of these systems are helmet-mounted, whereas the small adhesive patch targeted here would allow attachment to the skin, which is more closely coupled to the environment that the skull and brain experience, while also helping to minimize head-supported mass. Wearable sensors, especially skin-attached sensors with the flexible/conformal requirements therein, are still in their infancy [1], with most still larger than 100 square millimeters [2]. This research topic entails the design of the electronics necessary for monitoring an array of arbitrary digital sensors; incorporating these electronics into a flexible, stretchable, conformal substrate (references [3] and [4] are provided by way of example only and are not intended to limit the materials or methods used); and development of a method for transferring or assembling microelectromechanical systems (MEMS) sensors to the flexible substrate that is amenable to volume manufacturing. Methods for attachment or transfer of the MEMS sensors to the substrate must retain the inherent substrate flexibility. The resulting system should be completely self-contained, including power supply, some basic data processing/analysis, real-time clock, data storage for at least 100 time-stamped magnitude/duration events, and radio-frequency (RF) communications for programming and data retrieval. Battery and individual electronic components (microprocessor/radio/memory) may be COTS, but size and mass are at a premium to promote maximum flexibility and minimum footprint. The substrate should be both flexible and stretchable to allow for attachment on various three-dimensional body parts. The overall system size should be no larger than a standard band-aid (approximately 1.9 x 5.75 cm), no thicker than 4mm at the widest point, weigh less than 3 grams, and should be attachable via standard medical adhesives. Desired minimum radius of curvature is 0.6 cm to accommodate wrapping sensors around thinner body parts such as the nose or fingers. The system should last at least one month while continuously monitoring on a single battery charge, with at least 5 data collection/transmission events covering a minimum of 50 meters. Expected maximum current draw is for the wireless data transmission, approximately 20mA. Sensor power draw is expected to be less than 100uA during an event. Data sampling during an event should be at least 20 kilohertz or equivalent, triggered by an interrupt from the sensor. The system should be awake and recording data in less than 20 microseconds. The sensors (to be chosen by ARL) will be provided in standard surface-mountable leadless chip form factor. Provisions for at least 15 digital outputs from the sensor should be provided for flexibility in accomodating arrays of sensors in a single package.

PHASE I: During phase I the performer will design the electronic data collection, storage, and transmission system and select components, and demonstrate feasibility of proposed method for assembling sensors onto flexible substrates. A full analysis of power consumption and anticipated battery life is expected during this phase. Phase I deliverable shall be a final report to include details of the system-level design and architecture, demonstration of the assembly of the sensor and other components onto the flexible substrate, and calculated/anticipated mechanical (radius of curvature limits for attachment, strain sensitivity, etc.) and electrical (data sampling rates, transmission distance, battery lifetime, etc) performance.

PHASE II: During phase II, the implementation of the design from Phase I will be conducted. The electronics will be prototyped in the final flexible and conformal form factor to correctly interface with the digital MEMS sensors selected by ARL to interpret, store and transmit the data to a nearby laptop or handheld device. The system should be evaluated for mechanical (radius of curvature limits for attachment point, strain sensitivity, etc.) and electrical (data sampling rates, transmission distance, etc) performance. The sensors will be transferred/assembled onto the flexible substrates by the performer. Finally the performer will evaluate system performance and survivability with impact tests on a dummy headform. The phase II deliverables shall include a final report detailing the overall system design and performance. In addition, the contractor shall deliver twelve (12) prototype flexible, conformal assemblies with all of the electronics and sensors integrated thereon.

PHASE III: In phase III, follow-on activities are expected to be aggressively pursued by the offeror, namely in seeking opportunities to commercialize the skin-attach sensing system developed during phases I and II. Potential military applications include impact/blast personal monitoring systems for Traumatic Brain Injury early warning. Commercial applications of the conformal wireless sensor assembly include TBI sensing for sports such as football, hockey, soccer, rugby, and others all the way from junior leagues to professional levels. There is considerable interest throughout the athletic community in better tools to immediately determine severity of a hit or fall and the need for medical attention. It is also expected that the TBI sensor will not be the only application of the underlying technology – for instance, band-aid form factor heart rate or perspiration sensors would also have wide application in athletics. The electronics would ideally be developed in a sensor-agnostic way so that other sensors can be easily integrated into the system with no hardware changes and minimal software changes.

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KEYWORDS: flexible electronics, sensors, traumatic brain injury, TBI, wearable sensors

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A13-016 TITLE: Identification of Material Damage Precursors using novel Nondestructive Evaluation and/or Structural Health Monitoring Hardware

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective of this program is to develop a nondestructive evaluation or a structural health monitoring product (hardware) to be able to detect fatigue damage precursors in a metallic or a composite air vehicle (aircraft or rotorcraft) component and develop an accurate remaining useful life methodology. The overall objective is to develop quantitative methods and tools to improve life prediction of materials by identifying the damage precursors at an earlier stage than current state of the art.

DESCRIPTION: Current service life prediction methodology, especially for critical air vehicle structures, often fails to provide adequate warning of impending failure. Fatigue life prediction based on crack length measurements and existing analytical methods can be grossly inaccurate, when based on early service life data, and often too late for effective action, when based on easily measurable crack lengths during the final service life regime. Thus to improve remaining useful life prediction of structural components, the study of damage precursors is important. For the purposes of this program damage is defined as a process that compromises the structural integrity of the structure. Examples of structural damage are delamination, cracks, accumulated dislocations, porosity, surface galling et al. The structural integrity is the ability of the structure to perform the designed task e.g. structural load carrying capacity, thermal barrier and lift. A damage precursor is defined as the progression of structural material property degradation or morphology that can evolve into damage. Some of the known damage precursors are dislocation density, adiabatic shear bands, crazing, slip bands, residual stress, and structural inclusions. Precursor indicator is the measurand of the precursor, direct or indirect, e.g. measurement of change in electrical resistivity as a measurand of dislocation buildup due of fatigue of a metallic component. This program is initiated to develop novel non-destructive evaluation techniques resulting in development of the appropriate nondestructive evaluation / structural monitoring hardware for damage assessment and life prediction, enabling an earlier start of the inspection cycle focused not only on the detection of damage but on the detection of precursors to damage, appearing earlier in the service life. This requires understanding the relationship with how the damage precursors evolve into damage. The objective of the nondestructive method is to identify the fundamental property changes that occur during processing as well as during service that lead to precursors to damage. The nondestructive evaluation hardware will be developed based upon the measurands that quantify changes in electronic and magnetic structure, crystal and crystal defect structure, grain, grain boundary and phase structure, chemical and electrochemical structure, thermal properties, density, and internal residual stresses. This project is intended to study the use of acousto-ultrasonics, eddy current-, thermography-, x-ray diffraction, multiscale modeling and other techniques, to detect pre-damage indicators, such as plastic regions, crazes, shear bands, dislocation tangles etc resulting in development of the nondestructive evaluation product. A multi-spectral or multi-domain approach can be proposed to expand the horizon for material state awareness using new nondestructive evaluation or structural health monitoring hardware or tools. This allows the user to make decisions based upon information across multiple domains and spectrum. This will lead to improved existing experimental and analytical tools as well as creating new tools and methods for successful characterization of potential precursors.

PHASE I: This phase is primarily intended for identifying and developing a novel nondestructive evaluation product to detect damage precursors. The proposed nondestructive evaluation product will need to be able to measure the precursor indicators to satisfy the goals of this program. A nondestructive evaluation method needs to be applied on a structural (metallic or composite) coupon subjected to fatigue loads will be a requirement for Phase II funding. Prognosis methods based on data from the chosen NDE technique should be able to predict remaining useful life (RUL) of the coupon within 10% error on or before 50% of the total useful life of the coupon had been expended.

PHASE II: This phase is primarily focused on further development of the nondestructive evaluation product (hardware) and deployment strategies. The probability of detection by the developed product for nondestructive evaluation of the damage precursors leading to damage needs to be at 90% with a 95% confidence rate. The validation and the verification of the method ought to be demonstrated on a military rotorcraft or aircraft primary structural component or subcomponent at laboratory environment. Prognosis methods based on data from the chosen nondestructive evaluation product should be able to predict remaining useful life (RUL) of the component within 5% error on or before 25% of the total useful life of the component had been expended.

PHASE III: This phase is to miniaturize, package and transition the developed nondestructive evaluation technology to the original equipment manufacturers of both military and commercial aircraft. The developed nondestructive evaluation product should be demonstrated on a military air vehicle (rotorcraft or aircraft) component inspection for damage precursors at relevant environment. The developed nondestructive evaluation product needs to be a handheld or a miniature device that can be used during line maintenance or at the overhaul and repair maintenance depots for periodic inspection or structural health monitoring both military and commercial air vehicles.

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KEYWORDS: CBM, Structural Health Monitoring, Material State Awareness, Fatigue life management, damage tolerance, Nondestructive Evaluation Methods, Remaining Useful Life Prediction.

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A13-017 TITLE: Secondary Processing Development and Prototyping of Cast Single-Piece Vehicle Underbody Structure

TECHNOLOGY AREAS: Ground/Sea Vehicles

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and prototype highly scalable processes to fabricate single-piece underbody structures to achieve a combination of high strength and high toughness.

DESCRIPTION: The Army is interested in the production of large single-piece underbody structures for combat vehicles. The structure must possess an outstanding combination of strength and toughness for it to survive battlefield threats. In general single-piece structures are produced by casting and followed by subsequent secondary processing to achieve the desired mechanical properties in the structure. It has been demonstrated that a cast steel material after appropriate post-cast secondary processing exhibits a combination of strength and toughness as high as 180 ksi tensile yield strength, 230 ksi ultimate tensile strength, 12% tensile elongation, and 30 ft-lb Charpy V Notch (CVN) toughness at -40°F[1,2]. Unfortunately such remarkable mechanical properties are achievable only in relatively small cast structures. Suitable scalable secondary processing techniques are not currently available which could be applied to large single-piece cast structures to achieve the aforementioned mechanical properties. The challenge here is to establish scalable secondary processes for very large single-piece structure to achieve the required combination of strength and toughness. Additional challenge is to achieve uniformity of the properties throughout the entire large single-piece structure including through thicknesses.

Army is inviting proposals to develop and prototype highly scalable processes to fabricate large single-piece underbody structures with a combination of high strength and high toughness throughout the entire structure and thickness. The process must be scalable and be able to integrate relatively smoothly to very large scale fabrication or production under the standard manufacturing practices without needing nonconventional manufacturing equipments or processes beyond what are currently used. Army is seeking proposals that address novel processing techniques, such as innovative casting, robust post-cast processing, or other equally innovative and robust processes, that can be easily integrated with the existing manufacturing bases to enable smooth transition to large scale processing of large single-piece structure.

PHASE I: Design processes to produce plates having nominal dimension of 4 ft wide x 4 ft long x 3 thick. Demonstrate that the designed structure is able to achieve the Phase I threshold properties of 180 ksi tensile yield strength, 230 ksi ultimate tensile strength, 12% tensile elongation, and 30 ft-lb Charpy V Notch (CVN) toughness at -40°F. Two (2) 4 ft width x 4 ft length x 3 in thickness plates meeting the aforementioned threshold properties shall be produced. Verification and validation of the uniformity of the properties throughout the entire structure is critical and one (1) of the two (2) identically processed plates shall be destructively evaluated accordingly following the ASTM standards [3-5]. Uniformity of the properties throughout the entire plate including the thickness must be evaluated. For example, it may be evaluated in x, y, and z reference orientations within every 1 ft x 1 ft spacing in the x and y reference orientation at two positions in the z-direction: one at the mid-point of the plate and the other half-way between the mid-point and the surface. The plate not destructively tested shall be delivered to U.S. Army Research Laboratory for blast tests. The secondary process design preferably be suitable not only for processing simple structures but also for processing complex shape large structures. Additionally, the secondary process design must be sufficiently adaptable such that it can be directly integrated into the existing conventional manufacturing infrastructures or foundry processes without needing nonconventional manufacturing equipments or processes beyond what are currently available and used commercially. Numerical methodologies in process model and simulation are highly desirable in demonstrating the Phase I secondary process predictability.

PHASE II: The Phase II program will be to scale up and optimize the process to produce larger plates and subsequently to an entire single-piece vehicle underbody tub (i.e., lower hull and underbelly). Two (2) plates having nominal dimension of 6 ft wide x 10 ft long x 3 in thick shall be fabricated and achieved the same threshold properties of the Phase I. Verification and validation of the uniformity of the properties throughout the entire structure and through the thickness is critical and one (1) of the two (2) identically processed plates shall be destructively evaluated accordingly following the ASTM standards [3-5]. Uniformity of the properties throughout the entire plate and thickness must be evaluated. For example, it may be sampled at every 2 ft in the x-y plane. The plate not destructively tested shall be delivered to U.S. Army Research Laboratory for blast tests. Following successful validation of the plate properties, one (1) full single-piece vehicle tub (i.e., lower hull and underbelly) having nominal dimension of 12 ft wide x 30 ft long x 5 ft high and thickness between 2 in and 3 in shall be fabricated and delivered to U.S. Army Research Laboratory for blast tests.

The process shall be validated to be sufficiently predictable, adaptable, flexible, and robust such that it can be directly integrated into the existing conventional manufacturing infrastructures or foundry processes without needing nonconventional manufacturing equipments or processes beyond what are currently available and used commercially. Numerical methodologies of Phase II processes shall be developed and the model and simulation shall be demonstrated to be highly predictable.

PHASE III: The manufacturing technology shall be transitioned to civil and military sector applications. . Successful Phase II validation facilitates immediate single-piece vehicle hull and cap fabrication, and integration of demonstrated technology. The manufacturing technology and force protection capability information will be transitioned to both Tank Automotive Research and Development (TARDEC) and Tank Automotive Command (TACOM) for immediate implementation and integration into existing and future platform design and engineering efforts. Deliverables and technical data packages (TDPs) resulting from this SBIR will support a variety of Army PEOs and PMs in Army major acquisition programs. The manufacturing technology to civilian application enable very-large-scale complex-shape cast structural part in ship hulls, transportation vessels, and energy infrastructures where unnecessary joining are critical design requirements.

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4. ASTM E1820-11 Standard Test Method for Measurement of Fracture Toughness.

5. ASTM E23-07 Standard Test Methods for Notched Bar Impact Testing of Metallic Materials.

KEYWORDS: single-piece, underbody, high strength, high toughness, innovative processing, scalable processing, casting, post-cast processing, tensile test, Charpy V-notch test, fracture toughness

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A13-018 TITLE: Development of linear/non-linear radar system

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Development of a high dynamic range ultra-wideband radar system for ground-vehicular or dismount (hand-held) standoff detection of buried and surface laid improvised explosive devices (IEDs) that exploits the linear and non-linear responses of targets.

DESCRIPTION: Standoff radar detection of IED components provides safety and maintains maneuverability for the war fighter. Combining linear and non-linear radar techniques shows promise for increasing the standoff distance, detection rates, and decreasing false alarms. Linear responses are generated from targets illuminated by traditional radar pulses and chirps. The majority of Ground Penetrating Radars (GPRs) use a wide-band pulsed source, however it is possible to use a stepped frequency source [1,2]. Nonlinear responses are generated from targets illuminated by waveforms such as high-power single- and multi-tones [3,4,5]. These responses are used to detect electronic targets not seen by a conventional linear radar.

A radar system with waveform agility is desired for the purpose of compatibility with other RF systems on the battlefield and for detection of a wider range of targets. There are many possibilities for the realization of the radar system. For instance, by using a multi-tone frequency source, it is possible to combine both the linear aspects of ground penetrating radar and the non-linear radar detection of electronics into a single sensor system.

The desired parameters of combined linear and non-linear radar are:
- High linearity (spur-free dynamic range > 100 dB)
- Wideband transmit frequency range within (300 – 2000 MHz)
- Variable frequency resolution, if using stepped and/or multi-tones (< 100 kHz)
- Standoff ranges appropriate for application
- Minimal radiated power
- Simple-to-understand user interface

PHASE I: Phase 1 expected deliverables are a detailed linear and non-linear radar system design, a trade study of system designs, a trade study of components, and a feasibility study of detection distances given the system design. The radar should have the option to switch between the linear and non-linear mode.

Design should cover the desired Phase 2 desired characteristics, including dynamic range of transmitter, transmitter and receiver frequency bandwidths, frequency resolution, and radiated power.

PHASE II: Phase 2 includes the development and delivery of a brass board combined linear and non-linear radar system (transmitter, receiver, antenna, controller). There will be a demonstration of the radar system in an anechoic chamber. The radar system should have an easily understood user interface for the control program. Phase 2 also requires a written system design report detailing progress made during Phase 2 design.

Desired characteristics:
- Dynamic range on transmitter of > 100 dB (including harmonic and intermodulation distortion)
- Transmit frequency bandwidth in the range of 300 – 2000 MHz (does not have to cover entire range)
- Receive frequency bandwidth in the range of 300 – 4000 MHz (does not have to cover entire range)
- Variable frequency step size between 100 kHz to 20 MHz (if stepped frequency used for linear radar)
- Standoff ranges appropriate for application (0-5m for dismount, 5-30m for mounted)
- Radiated power less than 100 Watts
- Simple-to-understand user interface

PHASE III: Phase 3 includes the development of a prototype system (transmitter, receiver, antennas, controller) and evaluation of prototype at a government test range with realistic surrogate targets. The prototype can be either for mounted or dismounted applications. Multiple military and civil organizations are interested in handheld and mounted GPR technology. Additionally, government agencies such as the Department of Homeland Security may be interested in the prototype technology for portal detection of obscured objects at border screening points and airports. Commercial applications for the prototype technology include recording or communications electronic devices in a secured area, such as prisons or classified processing areas.

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KEYWORDS: Ground penetrating radar, non-linear, IED detection, handheld

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A13-019 TITLE: <u>Determination of Terrain Ponding for Logistics Emplacement and Planning</u>

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: To determine a methodology for predicting logistics site selection and emplacements (distributing bulk fuel, ordinance, personnel, supplies, etc.) by combining weather effects and terrain suitability (elevation, slope, etc.) to create operational overlays to assist warfighters in planning sustainment operations. Innovative technologies for obtaining and ingesting soil and soil-related information in conjunction with terrain and environmental information must be developed. Demonstrate that these methodologies can be developed into algorithms that perform terrain and weather effects analytics using national geospatial agency (NGA) commercial or open mapping toolkits such as the JMTK or OpenMap.

DESCRIPTION: Research is required to develop innovative methods and algorithms for determination of key information on local terrain elevation and soil conditions, affecting accumulated precipitation and subsequent runoff from recent rainfalls for inclusion in the My Weather Impacts Decision Aid (MyWIDA). MyWIDA[1,2] is a rule-based weather expert system and therefore it does not contain rules relative to terrain impacts on systems. Rules may be obtained from either Army Field Manuals or Subject Matter Experts (SMEs). Since weather and terrain vary considerably, dependent on location, SMEs play an important role in determining acceptable limits to such rules. The resultant model would be capable of determining logistical emplacements that are subject to ponding and flooding thereby providing the logistics community with a planning tool for advance determination of terrain and weather impacts on the supply chain. Processes such as ponding are highly dependent on the soil strength and type and determination of that information in arbitrary locations is a frequently difficult and time consuming task. Soil strength is in part dependent on soil moisture and on the distribution of water with depth in the soil and it is not possible to extract sufficient soil moisture information directly from satellite data. Thus in situ measurements, state-of-the-ground models[3], statistical methods[4], or other innovative techniques are required. The goal of this project is to augment Army logistical rules for terrain coupling MyWIDA's weather impacts to these newly developed algorithms to avoid potential and predicted ponding areas in arbitrary locations. MyWIDA does not have the necessary terrain rules, algorithms or data to predict areas prone to ponding. Research and development of this capability for inclusion into MyWIDA will define exclusion criteria to ensure that unsuitable locations are avoided. As an example, when distributing bulk fuel, terrain elevation along the planned route is a key factor that impacts the amount of equipment needed to implement a pipeline system. Ponding of water can impact the ability to traverse the route and could place the pipeline under water resulting in extreme stress to the pipeline along the distribution route. Development of innovative technologies that can be used by MyWIDA will aid in streamlining logistics processes enabling faster deployment, improving mobility, and more effectively sustaining operational forces. For MyWIDA to make use of such information (rules provided in Excel® are acceptable) it must be available in either database format, statistically derived from remote sensing capabilities such as satellites, or by other means that can provide such information. Terrain rules, algorithms, precomputed or preprocessed data or other means of obtaining and processing such information speedily is necessary for MyWIDA's results to be viable. This project would result in and make available a new and flexible application based methodology, providing reliable data for training, analysis and logistical planning.

PHASE I: Perform exploratory research using military SMEs as well as Army and Defense Logistics Agency documents to identify rules used by Petroleum and Water planners when deploying the Assault Hose Line System (AHS)[5], Inland Petroleum Distribution System (IPDS)[6], and Tactical Water Distribution System (TWDS)[7] for fuel and water sustainment. Develop an appropriate methodology that will determine ponding and which can be employed by MyWIDA. The technique must be applicable to locations with the area of interest and be able to obtain and reduce the required data within a reasonable time frame (<1 day). Subsequent usage of this (pre-computed, preprocessed, or real-time) data must be easily ingested into the My WIDA framework for examination and usage.

PHASE II: Develop Implement, test and demonstrate algorithms and techniques for determination of areas subject to ponding terrain and weather system rules resulting in thematic overlays for suitable logistical emplacements. Demonstrate that such algorithms and associated data will work in concert with MyWIDA in concert with a bulk fuel distribution scenario involving AHS, TWDS, or IPDS in an austere setting. This demonstration should include a variety of terrain-related considerations (such as ponding) that will require weather and terrain rules to fully describe the terrain suitability to determine optimal AHS, TWDS, or IPDS routes. Results must be suitable for verification and validation purposes.

PHASE III: The technological capability developed would have many beneficial civilian and commercial applications, and a high potential for commercialization. Some examples of commercialization to first responders and other civilian applications include: US Army Corps of Engineers (USACE) civil works programs and projects, and emergency response; Federal Emergency Management Agency (FEMA) first responders to natural disasters (e.g., fires, volcanic eruptions/explosions, earthquakes, floods, severe storms, tornadoes and hurricanes) and man made disasters (e.g., nuclear power plant accidents, explosions, and toxic spills); and general support to emergency operations, evacuations, field services (medical, food/water), and contamination control. Terrain suitability analysis has a wide applicability to not only logistics but also to the wider defense and commercial communities as well.

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KEYWORDS: logistics, weather, decision support, rules-based, ponding, terrain suitability

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A13-020 TITLE: Nano-Inspired Broadband Photovoltaics Sheets

TECHNOLOGY AREAS: Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Design and develop proof-of-concept light-weight, flexible and rugged photovoltaic sheets capable of converting solar radiation into usable electric power that can meet or exceed the Soldier's requirements for low to moderate power and be scalable for use in higher power mobile/field applications, thereby extending the lifetime of batteries for off-base missions, power telecommunication equipment and to support Army logistics systems.

DESCRIPTION: Photovoltaics show immense promise for supporting Soldier and mobile/field power. However, current technologies (silicon) that are dominating the commercial market are unable to provide the high power per weight required for the dismounted Soldier, and the best prospects require substantial improvements to meet the insatiable demand (high power, light-weight, low cost) for Soldier power. The maximum theoretical efficiency for the photovoltaic conversion of unconcentrated solar radiation that can be achieved in conventional single-junction solar cell is given by the Shockley-Queisser limit of 33.3%. By employing photovoltaic nanomaterials this limit can be exceeded due to multi-step absorption and/or multi-exciton generation. Taking into account this challenge and the vast opportunities nanotechnology provides, the main goal of this program is to develop photovoltaic nano-materials for demonstrating prototypes of single-junction devices that exceed the Shockley-Queisser limit, and to integrate the technology into flexible and light weight photovoltaic sheets with power requirements in the range of 4W to 20W and scalable for use in mobile/field power (200W to 1kW). The footprint of these photovoltaic sheets can be defined as within 22cm x 34cm with a power density >200W/m^2. This can potentially extend the lifetime of batteries for ~72 hour missions, power telecommunication equipment and support Army logistics systems. Significant improvements in photovoltaic devices can be achieved due to the following nano-inspired technologies: (i) Nano-patterned coatings for advanced light trapping schemes; (iii) Nano-enhanced absorbers in IR range; (iv) Advanced windows based on novel transparent conductors; (iv) Bandstructure nano-engineering for high conversion performance; (v) Nano-engineered electron processes for suppression of thermalization and recombination losses. These technologies can potentially lead to the broadband operation with strong harvesting and conversion of below-bandgap photons. However, one potential technical barrier associated with implementing nano-inspired technologies is that small bandgap materials will increase the dark current and decrease the open circuit voltage. Therefore, the novel photovoltaic devices should utilize materials that allow for flexibility in bandgap tunability and must be based on reliable fabrication technologies that are potentially lower in cost compared with the state of the art multi-junction solar cells. The photovoltaic devices are expected to be scalable to facilitate integration into large photovoltaic sheets. The developing novel technologies should be universal enough for all-weather photovoltaics conversion as well as for use in thermo-photovoltaic applications. This program has the potential to feed CERDEC's Soldier wearable nano-grid energy harvesting program.

PHASE I: Efforts should include modeling and analysis of the type of nanomaterial, thicknesses, and compositions as well as investigate the relation between bandstructure, wavelength and structure to determine the feasibility of the proposed innovation. Therefore, at the end of Phase I, the technical merit of the approach proposed for exceeding the Shockley-Queisser efficiency limit should be presented in terms photocurrent (>25mA/cm2), external quantum efficiency (>85%) and open circuit voltage (>0.9V).

PHASE II: Knowledge gained from models developed in Phase I should be applied for designing and developing a representative proof-of-concept solar cell device incorporating novel nanomaterials and advanced nanophotonic technologies. At the end of Phase II, the proof-of-concept photovoltaic sheet should demonstrate at least 25% photovoltaic efficiency at AM 1.5G. The overall success will be evaluated by direct comparison with performance and functionality of the state-of-the-art multi-junction solar cells. Demonstration of proof of concept light-weight (~6.5W/g) and flexible (curvature of radius of at least 3 inches) photovoltaic sheets with a power density of >200W/m^2 within 22cm x 34cm. The sheet should produce a power of 10W under AM1.5G illumination.

PHASE III: Development of modular PV sheet designs that allow scalability to the high power mobile/field application is expected to be aggressively pursued by the offerer. Commercial benefits include increased competitiveness for more providers of high efficiency, light weight PV sheets for use by the fielded soldier on extended missions.

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KEYWORDS: nanomaterials, nanophotonics, photovoltaics

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A13-021 TITLE: Non-linear Dynamic Energy Altering Technologies for Body Armor Applications

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop and demonstrate novel state of the art materials and/or technologies to eliminate or reduce behind-armor-blunt-trauma (BABT) without a compromise in ballistic performance.

DESCRIPTION: A commonly utilized method to dissipate the energy from an armor-piercing small or medium caliber ballistic projectile event involves the use of metal or composite backings. These materials are usually bonded behind ceramics onto metal and/or composite backings with low-density, low-impedance, and low shear strength adhesives. The subjects of understanding the dynamic energy dissipation methods or energy harvesting capability of materials under impact are areas of concentrated investigation that will forge the development of new solutions for protection. In anticipation of new and/or unforeseen threats as they emerge, continual improvements in armor systems are necessary. Beyond the revolutions in materials technologies that design engineers may come up with, alternative means of improving armor systems are required.

It is understood that the effectiveness of small-arms-protective-insert (SAPI) plates can be increased if the energy transferred can be dynamically altered (mitigated or utilized in another form) to reduce the trauma inflicted on the soldier during the ballistic arrest on the SAPI plate. Therefore, the focus of this program is to fundamentally explore methods for enhancing the performance of SAPI plates through the development of advanced materials and/or processes that synergistically work together to mitigate or utilize another form of energy from a projectile's interaction. Critical technology areas to be addressed include non-linear dynamic energy dissipating mechanisms, non-linear dynamic energy displacement mechanisms, metamaterials, electromagnetic shock waves systems, advanced shock wave systems, and electroactive polymers.

The primary objectives are to conceive, devise, model, fabricate, and experimentally validate advanced energy altering concepts and configurations that may be able to eliminate the behind armor blunt trauma from a SAPI plate. The advanced energy altering concepts and configurations must able to achieve and exploit dynamic energy altering mechanisms within the duration of the arrest (on the order of 1.0 millisecond). The advanced energy altering concepts and configurations must be lightweight and able to be scaled for threat escalation in the future. The advanced energy altering concepts and configurations will be evaluated against a baseline armor configuration. One will need to think about how to separate SAPI development and BABT reduction. These are two different things, but they are related. One can have a piece of material which would give you very low back face deformation, but the ballistic performance is very low. This topic requires the best ballistic materials/configurations/processing and at the same time, the lower backface deformation - that's the challenge.

PHASE I: Phase I will focus on the fundamentals and conceptual feasibility. The advanced energy altering concepts and configurations must be lightweight and able to be scaled for threat escalation in the future. The advanced damping concepts and configurations will be fundamentally (modeling or otherwise) evaluated using a 6.5PSF (pounds-per-square-foot) "armor plate/insert" design, must stop APM2 capability against one shot from a APM2 projectile, and yielding a BABT (using current clay measurement) of 25mm or less BABT. The advanced energy altering concepts should have a quick response time that can reduce BABT without a weight penalty and no compromise in provide an equal ballistic performance. A successful Phase I will be determined by the quasi-static experimental validation of the "armor plate/insert" design concept to mitigate shock propagation and reduce BABT from a small arms impact. PM Soldier will support the conceptual effort during this phase.

PHASE II: Phase II will focus on the experimental validation, integrating the Phase I concept into an "armor plate/insert" prototype for evaluation. The contractor will design, fabricate, and test both new advanced materials and dynamic processes to validate performance and applicability. All final evaluations will be conducted at The Army Research Laboratory. The advanced materials and dynamic processes must demonstrate improved deformation reduction at a competitive ballistic performance in a prototype lightweight protection system. PM Soldier will support the validation effort during this phase.

PHASE III: The advanced protection component will be inserted into a SAPI system and transitioned for use to PEO Soldier. The advanced protection component will be commercialized into law enforcement protective equipment and athletic protective equipment (i.e. football, baseball, lacrosse, and National Association for Stock Car Auto Racing (NASCAR)).

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KEYWORDS: soldier protection, body armor, energy dissipation, energy harvesting, nonlinear dynamic energy mechanisms, active protection, lightweight armor, vehicle protection, survivability

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A13-022 TITLE: Survivability Improvements for Transmission Loss-of-Lubrication

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: Provide innovative technologies that can improve the ability of military vehicle transmissions to withstand operation under loss-of-lubrication conditions, specifically in rotorcraft. Extend the amount of time allowable between the loss of primary lubrication and termination of the mission. Technologies must be applicable to rotorcraft main transmissions, although technologies with applicability to other vehicle transmissions are encouraged.

DESCRIPTION: Loss of the primary lubrication system in vehicle power transmission systems can result in an immediate or rapid failure of the drive system due to the degradation of tribological performance in the highly loaded gear contacts and reduced heat transfer. Army rotorcraft are currently required to operate for thirty minutes after the loss of the primary oil system, often requiring the addition of secondary emergency lubrication systems which add complexity and weight.

To increase vehicle survivability and extend this period to at least half-mission duration, an improved portfolio of technologies is sought to improve transmission performance after the loss of the primary lubrication system. Technologies to achieve this include, but are not limited to: modified gear materials and/or treatments that can better withstand high temperature starved lubrication, lubricant formulations specifically designed for use after failure of the primary system, and specialized delivery implementations to provide adequate lubrication in gear and bearing contacts.

Proposers must offer an innovative approach to assuring transmission performance after loss of oil. Slight modifications to existing or well known solutions are not acceptable. Proposals should describe in detail the candidate technology under consideration for improvement of transmission oil-out performance. The most promising technologies will allow the transmission to operate under any conditions within the normal design envelope rather than restricting flight conditions, provide reliable and predictable performance from the initial oil-off event through the end of the mission, be reasonably insensitive to ambient conditions (temperature and altitude), and be scalable to longer required periods of operation beyond 30 minutes to at least 1-2 hours. Any weight, cost, and complexity penalties associated with the proposed technology must be at least 25% better than current fielded technology. Technologies which allow for controlled damage, such as high wear rates, to occur in the transmission during the oil-loss event are acceptable under this topic provided they can be scaled to at least 1 hour.

The proposer should select an approach to this problem that requires development of a novel technology such as those listed above. The successful effort would establish feasibility of the technology for rotorcraft transmissions and determine appropriate performance metrics for evaluation. The technology will be demonstrated in a successful Phase II effort and have a clear commercialization strategy providing a pathway toward adoption in military helicopters.

PHASE I: Explore the feasibility of the proposed technology for use in a rotorcraft transmission environment. Investigate issues relevant to integration with typical aviation drive systems and establish operational conditions and evaluation metrics to which the concept would be subjected. Conduct analysis and/or bench-level experiment to validate that the tribological performance of the transmission incorporating the proposed technology would be improved. Focus on aspects of the technology that are innovative and result in a commercial product. In the case of a novel lubricant formulation, for example, examine feasibility for its use in typical helicopter transmission application and develop an evaluation plan to optimize the formulation through performance testing.

Proposals for Phase I efforts should clearly explain how the proposed effort can provide a robust and predictable improvement in rotorcraft survivability following loss of the primary lubrication system. Offerors should address how the proposed effort would treat tribological phenomena, heat transfer characteristics, material properties, and system-level interactions. They should also address how the technology will be successfully commercialized through sales, licensing, etc. to helicopter OEMs and beyond.

PHASE II: Refine the technology developed in Phase I and validate its feasibility through some combination of subscale experimentation and simulation. Verify Phase I assumptions and required performance to design and execute an appropriate evaluation methodology. Examine the vehicle operational envelope to identify critical flight conditions under which the proposed technology will be most vulnerable. Conduct analysis of relevant rotorcraft-class systems to demonstrate that the concept will provide increased vehicle survivability by improving transmission oil-off performance. Determine reasonable endurance estimates for the proposed technology, in terms of aircraft mission endurance after the oil-loss event. Determine limiting physical mechanisms by which the transmission will ultimately cease to function under this operational mode. Identify performance and/or durability tradeoffs resulting from adoption of the proposed technology, including design compromises that may be made.

In the example of a technology allowing the transmission to run completely or nearly dry, establish experimental protocols which simulate the high power density and low heat capacity of rotorcraft transmissions to simulate the resulting high temperature. Examine wear and durability aspects of this extreme environment, as well as robustness and tolerance to transient and aggressive flight conditions. Establish estimates of usable life based on the range of expected wear rates. Determine fabrication/production issues and pathways to airworthiness certification.

PHASE III: Applications for the technology primarily include powerplant and drive systems for aerospace vehicles. Both commercial and military rotorcraft are clear benefactors of these technologies, as are other aviation propulsion systems such as turboprops and geared fans. Some proposed technologies may also be relevant to wind turbine gearboxes and other industrial power generation equipment.

In the example of improved gear materials or coatings/treatments, high performance and specialty transmissions would also benefit from these improved material systems through operation under more severe conditions and at higher power densities. High value mechanical systems might incorporate these material systems to provide additional performance margin.

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KEYWORDS: Gears, transmissions, drivetrain, lubricants

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A13-023 TITLE: Wireless Sensor to Monitor Generator Control Unit and Main Power Relay Health

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop an advanced, non-intrusive wireless sensor to monitor the electrical health of the Generator Control Unit and main power relays on Army rotorcraft platforms.

DESCRIPTION: Currently, there is a Department of Defense (DoD) initiative to transition the maintenance of weapons systems from time-based to Condition Based Maintenance (CBM). The intent of CBM is to reduce unnecessary maintenance burden, while improving and/or extending component life. The reduction of maintenance and prolonged component life will increase the operational availability of military weapons systems. A large amount of the unnecessary maintenance burden results from false removals of perfectly healthy components. The false removals are costly to the DoD, in the form of replacement parts, maintenance labor, and decreased operational availability of the aircraft. Therefore, to decrease the number of false removals and support the DoD's initiative to transition to CBM technology, this topic seeks to develop an innovative sensor that monitors the health of a rotorcraft generator control unit (GCU) and main power relays. The GCU has a No Fault Found (NNF) rate greater than 25%, making it a logical target for this sensor technology.

The goal of this topic is to develop a sensor that can diagnose GCU and main power relay failures as well as monitor and predict remaining useful life of the GCU. The offeror must consider the diagnosis of all failure modes of a particular GCU (e.g. loss of voltage regulation, loss of overvoltage protection). The desired attributes of the sensor are described herein. In order to avoid the additional weight burden of a wired sensor, the developed sensor must be lightweight and wireless. Also, the sensor must be non-intrusive (cannot alter the GCU or main power relays to avoid the cost, time, and difficulty in validating a modified GCU or main power relays). The sensor may be self-powered or draw minimal power from the GCU. Additional sensor requirements include: operate in a wide range of temperatures (-40 to +140 °C), provide diagnostic and prognostic health, contain a self-test, and be capable of storing and wirelessly transmitting data to an on-board Health and Usage Monitoring System (HUMS) as well as transmit data to a hand-held device for non-HUMS equipped aircraft.

Other desired attributes to consider for Phase III are (1) impact per Mil-Std 810G, Method 516.6; (2) vibration requirements of Mil-Std 810G, Method 514.6; (3) acceleration per Mil-Std 810G, Method 513.6; (4) altitude per Mil-Std 810G, Method 500.5; (5) rain per Mil-Std 810G, Method 506.5; (6) fungus per Mil-Std 810G, Method 508.6; (7) humidity per Mil-Std 810G, Method 507.5; (8) salt spry/fog per Mil-Std 810G, Method 509.5; (9) sand/dust per Mil-Std 810G, Method 510.5; (10) fluid susceptibility per Mil-Std 810G, Method 504.1; and (11) electromagnetic interference (EMI) per Mil-Std 461F as modified by ADS-37A-PRF Table 1.

PHASE I: Design and develop the architecture for the electronic sensor(s) to include its wireless communication configuration. Perform an analysis/bench test that demonstrates the feasibility of the concept electronics. Also, provide data to prove the wireless sensor weighs less than a wired configuration.

PHASE II: Develop and fabricate a prototype new sensor(s) and related electronics to demonstrate on a GCU and main power relays via bench test(s).

PHASE III: The wireless sensor technology is applicable to both military and commercial GCUs and main power relays (qualified to military standards listed in description) to monitor diagnostic and prognostic component health in real-time. Collaborate with original equipment manufacturers to develop a full production, market ready sensor to be used on rotorcraft GCUs and main power relays. As the technology matures, it can transition to other rotorcraft components for potential commercialization.

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Verification Requirements, 28 May 1996.

KEYWORDS: Sensors, wireless technology, condition based maintenance (CBM), generator control unit (GCU), main power relays, non-intrusive

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A13-024 TITLE: Advanced High Speed Overrunning Clutch for Rotorcraft Transmissions

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO Aviation

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate a novel, high speed overrunning clutch concept with high power density, low manufacturing costs and excellent durability and reliability.

DESCRIPTION: Overrunning clutches are a critical component of the drive train of all helicopters. The overrunning clutch prevents the flow of torque from the thrust producing rotors back into the engine(s) during autorotation and high energy maneuvers, and allows the individual start-up and shut down of engines on multi-engine aircraft. Conventional overrunning clutch designs rely on the friction of wedged shaped elements in the form of sprags or ramps and rollers to allow torque to be transferred in only one direction of rotation. The overrunning clutch is sometimes called a mechanical diode referring to its electrical analog. Other concepts utilizing expanding springs and helical splines with centrifugally actuated engagement mechanisms have been pursued over the last 20 years with limited success. The primary failure mode is failure to engage as a result of excessive wear of sliding surfaces accumulated during overrunning. Current overrunning clutches are located after the first geared reduction stage and thus operate at speeds between 8,000 and 6,000 rpm. Since weight is a direct function of transmitted torque, and torque is a direct function of speed, it is most weight efficient to locate and operate the clutch at the highest speed in the drive train. Typical turboshaft engine output speeds are 15,000 rpm for engines of 4000 hp or more and 20,000 rpm for engines up to 3000 hp. Achieving a long life in an overrunning clutch operating at these high speeds is challenging. This topic seeks to develop an innovative overrunning clutch design which minimizes the wear and heat generation associated with full and partial speed overrunning of clutches operating at high speeds. Overrunning clutches, as used in the main drive trains of multi engine rotorcraft operate in only three modes: locked, differential overrunning (input speed 50% to 70% of output), and full-speed overrunning (input speed zero and output speed 100%). The locked position is the most common occurring all times when the engine is driving the transmission. Differential speed overrunning, which is by far the worst condition for wear, occurs mainly during practice autorotations with both engines set to ground idle, and the main rotor over speeding up to 105% rpm. Full speed overrunning occurs mainly during engine start up and in flight with one engine inoperative (OEI). For a medium size twin engine utility rotorcraft without a rotorbrake, a typical lifetime is 12,400 flight hours. During this lifetime, 124 hrs will be spent in differential overrunning mode, and 426 hrs will be spent in full-sped overrunning mode with 12 of these hrs representing OEI operations. Modern sprag or ramp roller clutch designs (UH-60 and AH-64) are typicaly located after the first stage of reduction gearing and thus operate at speeds around 8,000 rpm with a static rating of 3000 hp. Given the design lives stated above, these clutches weigh approximately 20.00 lbs. This results in a power density of 150 hp/lb. This topic seeks to develop an overrunning clutch which can successfully operate at 20,000 rpm input speed (lower torque position) with a 30% increase in power density and no reduction in durability or reliability and the potential for reduced production cost.

PHASE I: During Phase I effort, the contractor should conduct a conceptual/preliminary design to analytically determine the potential performance, weight, durability and cost attributes of the proposed overrunning clutch design. The contractor should utilize a current rotorcraft manufacturer as a consultant for this effort. The results of this activity shall be presented to the Government for review. Technical challenges associated with key features of the proposed design shall be studied in more detail. Small scale coupon or bench testing may be conducted to to gather data regarding these key challenges and the merit of potential approaches towards their solution. Key performance metrics to be achieved in the design include operation at 20,000 rpm input speed, and 3000 hp, 30% increase in power density (195 hp/lb), reduced production cost and reliability equal to or greater than current sprag and ramp roller designs.

PHASE II: During Phase II, the contractor should utilize the results of the phase I effort and conduct a detailed design and analysis of the light weight high speed overrunning clutch design. The detailed design effort should fully evaluate the performance and durability of the proposed clutch in all of the critical operating conditions. The contractor should utilize a current rotorcraft manufacturer as a consultant for this effort. The results of the detailed design should be presented to the government prior to the initiation of hardware fabrication. The contractor should then proceed with fabrication of full scale hardware for use in validation testing. The clutch design should be tested for engagement/disengagement and full and partial speed overrunning at the full design speed of 20,000 rpm. Static testing may be utilized to validate the ability of the clutch to engage and transmit the full design torque. A TRL of 5 is the desired end-state of the Phase II effort. As in Phase I, key performance metrics include operation at 20,000 rpm input speed and 3000 hp, 30% increase in power density (195 hp/lb), reduced production cost and reliability equal to or greater than current sprag and ramp roller designs.

PHASE III: The Phase III program is envisioned as an effort where the advanced high speed overrunning clutch technology developed in the previous phases has proven to be attractive and has garnered the attention of a rotorcraft manufacturer to the point where they are willing to invest in it further. Additional effort under Phase III would include minor modifications to the design to further enhance producibility and reduce cost. Additional testing utilizing a rig that is closely representative of the actual aircraft installation would be conducted to fully evaluate the clutch durability. Upon successful completion of this testing the clutch would be assembled into the actual aircraft drive train and subjected to ground based testing followed by flight testing. Potential military applications include future upgrades to the Sikorsky uh-60, Bell-Boeing V-22, Boeing CH-47 and AH-64, and the Bell OH-58. The Army is also planning for the development of a new medium class of helicopters known as the Future Vertical Lift. This could be a future application of the clutch. The drive train requirements and designs of commercial and military rotorcraft differ very little. Thus the advance high speed overrunning clutch would have a strong transition path to commercial rotorcraft such as the Sikorsky S-76 and S-92, and the Bell 407 and 429.

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KEYWORDS: Helicopter, Clutch, Overrunning Clutch, Friction, Sprag, Transmission, Drive Train

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A13-025 TITLE: Wearable Sensor System for Monitoring Soldier Body Dynamics

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop a portable, lightweight, ruggedized, and comfortable wearable system for monitoring body and equipment dynamics during naturalistic movement outside the laboratory environment.

DESCRIPTION: As new equipment, body armor, and technologies are being developed for the dismounted Soldier, it is vital the effects of this equipment on Soldier movement can be evaluated in an operationally relevant environment. Kinematics and kinetics are two useful areas of science which can be applied towards evaluating the effects of clothing, weapon systems, and equipment on Soldier movement and performance. Current technology does not allow the collection of kinematic and kinetic data in an operationally relevant environment. There are two ways that are primarily used to collect or derive this data: 1) with a camera-based motion capture system and 2) inertial sensor systems. With a motion capture system, data collection is limited to a relatively small capture volume and markers must be attached to landmarks on the body, which can be blocked by equipment and body armor. When these markers are blocked, useful data cannot be collected. The commercially available inertial sensor systems are heavy and the sensors are too large for the systems to be worn comfortably under clothing. Additionally, these inertial systems are designed to track only body motion, not weapon or equipment movement, which is important for characterizing marksmanship performance. These problems inhibit our ability to collect kinetic and kinematic data to evaluate Soldier performance in an operationally relevant environment. The U.S. Army requires a system that can measure the 3-D position, velocity and acceleration of the Soldier’s head, trunk, limbs and equipment using small, lightweight sensors that don’t interfere with uniforms, body armor, or equipment. The system must be capable of sampling data at 2 KHz. The system must be accurate to 0.5 mm within a local coordinate system for the position of body segments and equipment. Additionally, velocity and acceleration measurements must be within 0.1% of the actual value. The system and software need to provide, derive, or integrate the following signals to sufficiently capture each Soldier’s movement: linear and angular acceleration, linear and angular velocity, position and orientation, joint torques and segment kinematic energy. In addition to the body kinematics, the system would be used to monitor the movement of the weapon and to track the weapon aim trace. At 25 m, the accuracy of the weapon aim point at the target should be 1.0 cm. This data should be transmitted wirelessly and viewable in real-time, as well as saved to a computer. The system should be weatherproof, rugged for data collection in any environment, and not impede Soldier movement. The system needs to attach firmly to the body, be resistant to breakage, loosening, and minimize motion artifact. Each sensor should be 2 cm x 2cm or smaller, and weigh less than 5 grams, including the rechargeable battery. The system should include a graphical user interface (GUI) for the experimenter to use when collecting and processing data, as well as access to source code for data analysis.

PHASE I: Develop hardware for body worn sensor array and approaches for analyzing 3-D segment and joint kinematics. A prototype system is expected at the end of phase I.

PHASE II: Refine kinematic measurement processes and expand the capability of the sensor array to quantify body kinetics. Demonstrate ability to collect kinematic and kinetic against current gold standards (3-D motion capture and force plates). Demonstrate feasibility by conducting a pilot study where the U.S. Army or U.S. Marine Corps shooters perform walking, running, and shooting trials, indoors and outdoors at range facilities at Aberdeen Proving Grounds or an alternate military facility. Provide results, including body segment kinematics and kinetics, weapon kinematics and kinetics, and weapon aim point. Provide source code and GUI for data collection and processing. At the conclusion of phase II, the system should be ready to collect biomechanical measures of Soldiers in field studies. Additionally, work with ARL personnel to seek customers and transitions for the system.

PHASE III: There is a wide variety of application for the end state of this research project. Future military uses include evaluation of weapon systems, Soldier equipment and body armor. Additionally, this system could be used for ergonomic evaluations of tasks and vehicles. Clinical applications for monitoring body dynamics include rehabilitation, prosthetics, sports medicine, and occupational health.

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KEYWORDS: Kinematics, kinetics, physical performance, body dynamics, marksmanship

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A13-026 TITLE: Wide Field-of-View Imaging System with Active Mitigation of Turbulence Effects for Tactical Applications

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Develop and demonstrate an innovative wide field-of-view (WFOV) imaging system with opto-electronic active mitigation of atmospheric turbulence effects for tactical scenarios.

DESCRIPTION: In conventional atmospheric imaging techniques, mitigation of atmospheric effects is achieved using digital post-processing of an image sequence that has been recorded with a passive imaging system. Quality of the raw image sequence has significant impact on the achievable final quality of images. Recent technology advances have lead to new capabilities in optical and electronic imaging hardware development that potentially enable improvements in image quality before an image is taken. Among these capabilities are: (1) the ability to adaptively control imaging system characteristics including wavefront shape, field of view, focal length, spectral band, polarization state. Both the imaging system, which includes controllable optics and sensors, and image processing algorithms should be considered as an integrated system in which sensor/imaging system structure is dependent on the processing algorithm, and the algorithm is designed taking into account advanced optical and electronic hardware; (2) the new potential for fast "on-the-fly" image pre-processing using advanced digital micro-processing, VLSI and focal plane array hardware. The potential merger of these two capabilities requires the development of new, specifically designed image processing algorithms. It is important that these algorithms be closely linked for optimal on-the-fly control of optical system characteristics, in order to provide feedback for on-the-fly optimization of imaging system characteristics. This topic seeks the development and demonstration of new capabilities (algorithms, integrated imaging, opto-electronic architectures) for active mitigation of atmospheric turbulence effects in Wide Field-of-View (WFOV) imaging conditions. With WFOV imaging through atmospheric turbulence, dynamical phase distortions along the propagation path can result in significant image quality degradation. This image quality degradation can be spatially non-uniform, especially for so-called anisoplanatic imaging conditions when phase distortions for distant image scene regions are not correlated. These conditions are especially challenging for conventional adaptive optics and image processing techniques, and require the development of new paradigms and imaging system architectures. Offerors should develop an innovative compact, light weight imaging system (visible or IR) with active mitigation of atmospheric turbulence effects for operation over tactical distances (0.5 km – 10 km). The system's Field-of-View (FOV) should exceed 2 mrad.

PHASE I: Effort may be directed toward the development of initial design of the proposed imaging system concept. Detailed algorithms for image processing and control should be in place and evaluated, using a combination of real data and high fidelity simulation, for effectiveness in turbulence mitigation efficiency under various representative FOVs and atmospheric turbulence conditions. Results should be documented. Strengths and deficiencies should be clearly identified. The preliminary design should be configured with optimized performance and ready for an opto-mechanical implementation during Phase II.

PHASE II: Effort may be focused on prototype development by integrating optical and electronic components. The utility of this prototype system in turbulence mitigation effects in tactical scenarios should be demonstrated. Based on this atmospheric evaluation of the image quality, the system should be optimized through algorithm refinement and electronic processing improvements. A working system with identifiable improvements in image quality should be available by the end of Phase II.

PHASE III: The prototype should be further refined toward commercialization. The offeror should work with Army scientists and engineers, along with industry partner, to identify and implement technology transition to military and civilian applications. Civilian applications include medical imaging, global environmental monitoring, and video surveillance.

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KEYWORDS: Atmospheric imaging, turbulence mitigation, image processing, adaptive optics

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A13-027 TITLE: Vehicle Spacing Determination and Display In Low Visibility Conditions

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Design and build a system that can determine the distance between two vehicles, display that distance to the drivers, and make that distance determination under low visibility conditions.

DESCRIPTION: Vehicle convoys are required during test operations of various munitions. For performance requirements, the vehicles are required to maintain constant distances apart. When conducting these convoys on dirt tracks, it becomes impossible for the drivers to maintain that distance, sometimes ruining data requiring additional time (costs) to re-run scenarios. Vehicle spacing is currently approximated using markers along the side of the track and visual markers on the vehicles.

In addition, automotive testing of ground vehicles in severe dust conditions is performed on a regular basis. This requires the test vehicle to drive behind a dust generating vehicle at 24-32 kph on a specially prepared dust course. To ensure the most severe dust exposure possible, the test vehicle must follow close enough that the dust it travels in is a nearly solid cloud (currently 20-30 meters; preferred, a controlled 10 meters), and visibility is sometimes measured in mere feet. As a result, vehicle spacing and alignment varies during the test and collisions are a constant hazard.

A system that provides the drivers the distance to the vehicle in front of them would reduce re-test time, increase data accuracy, and reduce safety issues for both drivers and equipment. The system needs to measure/calculate/determine the distance between two moving vehicles and provide that distance to the trailing vehicle

The system developed under this effort must meet the following performance goals:

Vehicle Spacing: 0-200 meters (± 0.1 meter)
Vehicle speeds: 0-50 kph
Number of vehicles: maximum of 30; 10 each in three separate columns (side-to-side distance not required)
Environmental Conditions: Full sunlight, moonless night, dust, rain ,snow
Output readable in direct sunlight and through heavy dust and rain/snow
Power: Self-contained (cannot run off vehicle power)
Rugged:
  Temperatures from -40 to +140°F
  Water and dust proof
  Withstand constant (6 hours per day) vibration from tracked armored vehicles

PHASE I: Perform a feasibility study in support of the development of a Vehicle Spacing Determination system which meets the specification above. Evaluate innovative technologies which may be used to build, integrate the system and leverage existing technologies. Perform trade-off analysis to determine the best approach for the Vehicle Spacing Determination system, and develop a preliminary design for the system.

PHASE II: Develop a prototype Vehicle Spacing Determination system. Demonstrate the system technology and characterize its performance.

PHASE III: The Vehicle Spacing Determination system developed under this topic could be implemented in combat vehicles that usually convoy to reduce collisions in low visibility conditions. The system could also be marketed to off-road vehicles to be utilized as an inexpensive obstacle/collision-avoidance system.

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KEYWORDS: Vehicle, distance, low-visibility, spacing

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A13-028 TITLE: Advanced Spectrum Monitoring

TECHNOLOGY AREAS: Electronics

OBJECTIVE: The contractor shall develop a methodology and system to reliably characterize the RF spectrum in an area and provide the data in real-time to a central control over bandwidth limited communications channels.

DESCRIPTION:
Background: The Electronic Proving Ground (EPG) and the Intelligence Electronic Warfare Test Directorate (IEWTD) are Developmental and Operational Testers for tactical electronic warfare systems, tactical communications, and large radio frequency (RF) networks. These systems are expected to be able to operate effectively in a very dense and complex RF Environments. Much of this testing is performed on open air ranges and the RF environment must be documented during these tests. In our testing we often are tasked to generate a tailored Electromagnetic Environment (EME) specific to the area of interest for the System Under Test (SUT) or to play out a specific operational scenario. Some scenarios are so specific that a set of signals and protocols must be transmitted in the correct sequence with the exact content in order to test an SUT. These special signal sets may be transmitted with additional environment signals or they may be in a more benign environment. Often spectrum analyzers are set up adjacent to each SUT to record the spectrum that it experienced and comparisons are made post test to see if all the primary/target signals were available and not interfered with to evaluate the performance of the SUT. Obviously a more efficient way of testing is needed as this has become more laborious as the spectrum becomes more crowed and complex. Also the RF spectrum is continuously monitored on our test ranges to maintain documentation of our test environment and detect encroachment of unauthorized or out of limit users. Current wide bandwidth digital systems

The problem with spectrum analyzers is that they are scanning devices and can miss short duration signals. Also they will report every noise spike above a threshold and miss any low amplitude signal below it. They will report continuous signals over and over scan after scan. Many of the SUT's will be set up at arbitrary locations without dedicated communications infrastructure and to have a real-time data stream from the spectrum analyzer would require a significant bandwidth for the amount of data being provided. Thus most of the time data is recorded and processed after the test day is over. Some wide bandwidth digital systems can approach this capability but cost approximately $500K per site, are very complex, and not ruggedized to survive the field test environment.

Description: The goal of this project is to develop methodology and instrumentation to improve overall RF spectrum surveillance (detection) and reconnaissance (signal exploitation) performance in tactical settings with innovative and adaptive architectures that are reliable, low cost, and have very high probability of intercept performance. The system should recognize that spectral signal density is a relative parameter and consistently adapt the surveillance resources to this changing signal space. This will include sampling techniques and spectral bandwidths better matched to the actual incident signal environment and without degradation to the surveillance performance. With better architectures, the reconnaissance performance effort in recovering signal internals will achieve high performance capabilities with similar reductions in data transmit bandwidth.

PHASE I: Identify adaptable, high performance surveillance and reconnaissance receiving system architectures that provide quantifiable improvements to the performance obtainable within an existing RF data link while maintaining a high probability of intercept. Propose low-cost means to implement the adaptive architectures and obtain high performance surveillance and reconnaissance data and transport it across the existing RF link, typically a form of 802.11. Propose a path to produce a rugged, survivable, field system and an estimated cost to produce the system in small runs of 10 units and the potential of 50 units.

PHASE II: Develop the selected approach on a full VHF/UHF spectral band using prototype low-cost receiving systems with adaptable spectral data collection means and methods. Use the EPG range as the surveillance and reconnaissance target and the current bandlimited RF links to document an improved capability. Baseline the existing performance and compare with that obtained with newer prototype, low cost surveillance and reconnaissance receiving systems over the same existing RF links. A significant cost performance ratio is expected to make this an attractive commercial product. Refine estimated costs for production runs of 10 and 50 units.

PHASE III: The intention for Phase III is to procure a production ready capability based upon the successful demonstration of Phase II. The form of this capability is unknown at this time but expected to be readily adaptable to existing RF monitoring systems and current EPG test operations. There will be many other Government customers for this technology to increase the fidelity and reduce the cost of their own range spectrum monitoring, also for use with military electronic surveillance systems. Commercial applications for this technology would include broadband spectrum monitoring and receiving systems.

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[3] “Evaluation of Spectrum Occupancy in Indoor and Outdoor Scenario in the Context of Cognitive Radio”, Matthias Wellens, Jin Wu and Petri Mahonen, Paper

KEYWORDS: Spectrum monitoring, RF monitoring, Frequency management

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A13-029 TITLE: Optimization of Real Time Image Processing Techniques for Low Power Soldier and Unattended Ground Sensors

TECHNOLOGY AREAS: Electronics

OBJECTIVE: To develop algorithmic approaches that address run-time code scheduling and internal processor chip resource allocation for active power management in Soldier borne and unattended ground systems real-time imaging. The algorithms must dynamically manage power consumption at all times given an image processing application, its processing load based on sensor frame rates of 30Hz or faster, input/output activity related to sending and or receiving various meta data, and current battery levels for mission applications where the Soldier carries the sensors.

DESCRIPTION: Camera technology has improved to the point of being included in many defense applications including those carried by the Soldier and those left unattended at key observation points. Power, weight, and size are extremely important as these systems typically are powered by batteries. Thus, even a 2 Watt solution can cause Soldiers to be overburdened due to the number of batteries necessary for mission times. Even so, the imagery provided has been shown to be extremely valuable in the performance of the various missions. The quality and sheer volume of information from inclusion of cameras in many applications is such that no human can effectively consume it while working other primary tasks. Automation is being pushed to help alleviate information overload in order to effectively utilize the data provided, even though this would increase the power needed beyond that required for the camera technology. The automation covers many aspects from low level functions such as image non-uniformity correction to higher level functions such as object detection and tracking. The higher level functions are those that aid the operator in terms of workload. The processing algorithms used to create the higher level functions typically require many operations on each individual pixel before arriving at a result. The processing load, storage, and Input/Output (I/O) activities require processors with high sustained processing throughput coupled to large memories to keep up in real-time. Vehicle mounted applications are better able to manage the power necessary of processing systems required for the automation. Processing systems for Soldier mounted or unattended sensor applications have been more difficult to achieve due to power constraints imposed on them. Mission requirements for Soldier mounted or unattended sensor applications are scaled down from those vehicle mounted systems in terms of range capability, I/O, and functionality. Even so, more and more higher level functions are desired to be included in these systems. Power consumption and weight are critical. Real-time management of application code and hardware resources to optimize power is an unsolved problem. Technology in the commercial market tries to optimize power in terms of battery life over a given time period. For example smart phones optimize systems to perform a constant level of wireless I/O and display while trying to achieve arbitrarily time length before recharging is necessary. Typically the industry uses some common activity such as the length in hours of a flight between coasts. This is as opposed to actively minimizing power to the lowest level possible, but still maintaining processing throughput, to keep the activity going for as long as possible. Minimizing power can also lead to smaller, lighter sensor packages. The ability to adjust power in real-time, enabling close integration of modules with the camera is an unsolved problem. An innovative solution would in an integrated fashion dynamically adjust power as a function of processing load by analyzing the processing steps of the image processing algorithm and dynamically utilizing the hardware capability to selectively power down areas within a processor itself. Obviously this algorithmic approach taken for dynamic power adjustments must be implementable for demonstration and testing purposes.

PHASE I: Develop an algorithmic approach to analyze image processing routines to minimize the power necessary for an overall application given a processor hardware architecture through a combination of code scheduling techniques and available processor hardware powering options. The goal is to minimize the power necessary to the fullest extent possible in order to reduce Soldier overburden. This initial algorithm should take advantage of existing hardware capability to power down selected sections of processor chips in real-time, including I/O ports to minimize required power. In order to test the algorithmic approach, develop a simple processor module test bed for initial algorithm testing. Integrate initial algorithms and test bed to demonstrate power reduction capability. Successful testing at the end of Phase 1 must show a level of algorithmic achievement such that potential Phase 2 development demands no major breakthroughs but would be a natural continuation and development of Phase 1 activity. The processor test bed for algorithmic demonstration could be based on FPGA technology if necessary.

PHASE II: Complete algorithmic developments. Develop prototype processor test bed with on-board memories and I/O capable of acquiring digital data directly from a camera as well as capable of being tightly coupled to or inserted into a camera itself. System must demonstrate a 50% improvement in power using the algorithmic power approaches over the same hardware module without the algorithmic power approach. The Government will GFE a sample image processing algorithm for demonstration purposes.

PHASE III: System will be utilizable in a soldier borne demonstration system at a U.S. Army test site. The algorithms and supporting test bed will also be utilizable in border protection by Department of Homeland Security. In private industry, the algorithms and processor test bed will be utilizable for law enforcement and all forms of perimeter security and protection.

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KEYWORDS: SWaP, camera technology, soldier borne systems, image processing, unattended ground sensors

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A13-030 TITLE: Data Disassembler/Reassembler

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Research, design, develop, and prototype a state of the art programmable digital data stream disassembler and reassembler system, including hardware, software and documentation. The system must be affordable, efficient and reliable, and must provide coherent data stream disassembly and reassembly, operating at the non-packetized digital bit level. The intent of this effort is to enable Department of Defense (DoD) and commercial Satellite Communications (SATCOM) users to utilize portions of unused spectral energy by distributing bandwidth over multiple frequencies and varied angular polarizations, and then be reassembled at the destination with as little bandwidth cost as possible over long haul communications. Though the area of immediate interest to the US Army is SATCOM, this technology can also apply to advanced terrestrial microwave communications. In any media, this technology economizes bandwidth use and also provides a layer of passive protection capability against both jamming and man-made scintillation via its data replication summing properties. Protection is furthered by having portions of data reside in two or more planes simultaneously.

Current communications technologies utilize inverse multiplexor techniques on circuits that require high overhead costs of packetizing ranging from 15 to 50% or more and are primarily deployed for terrestrial applications. These terrestrial techniques lack flexibility of indiscriminant data rate assignment and do not provide means to programmatically address path latency nor the level of energy per bit by path nor the non symmetrical distribution of multiple paths to accommodate SATCOM bandwidth fragments. These technologies often depend on return feedback via full duplex communications and are incapable of operating in simplex configurations. For years challenges in handling processing issues on a single path with the right level of power per bit has been difficult to model with absolute efficiency without mentioning the given pointing accuracy complexities from a satellite antenna payload in space to an intended ground segment receiver. Today’s tools within DoD can now predict and allocate the proper power and bandwidth based on a single stream of data fairly accurately depending on a static model of a given spacecraft. However, once this predicted path is allocated and assigned for live transmission for a user, the allocation remains as is until that mission ends. Missions ending and beginning each having different bandwidth and duration requirements often leave transponders heavily fragmented. To eliminate this waste and regain back the unused spectrum without mission disruption requires an effective method to use fragmented bandwidth. The ability to coherently disassemble a data stream into smaller usable size rates to consume the gaps of energy and re-aggregate the streams is a means to economizing bandwidth usage. In doing so there are many challenges. Some of the greatest challenges in SATCOM include latency, indeterminate bandwidth availability and varied levels of power. The object is to provide this capability as an alternate means to effectively harvest fragmented SATCOM bandwidth as well as to provide a low-cost passive means of inherent protection against jamming and man-made scintillation.

DESCRIPTION: This research and development effort is intended to develop enabling technology that does not exist for a new simplex SATCOM system by leveraging off of existing inverse multiplexing technologies combined with latency compensating technologies used on single SATCOM links today. The solution must demonstrate coherent processing to accurately disassemble and distribute data to four or more paths for long haul over the air transmission. A data stream assembly process, complimentary to the data stream disassembly process on the transmission side, will be required on the receiving side of the communication system in servicing the data side of four or more receivers. The new system will provide a multitude of new benefits such as the ability to transmit large amounts of data across multiple small antennas; the ability to improve bandwidth usage efficiency by sending slices of data across multiple poles of the same antenna. Current circuit capabilities in operation terrestrial deployment are designed around fixed synchronous rates that are largely packetized requiring full duplex feedback and fixed levels of power and do not handle varied latencies and levels found in SATCOM. The solution must address these SATCOM issues adequately and at the same time use minimal overhead techniques such as super-framing and framing to retain a level of efficiency great enough to stay below the 5% threshold. Leveraging the use of dedicating a single path as reference with the association to all other adjacent paths of distribution for coherency is strongly encouraged but independent handling of each path without specifying a path of reference is acceptable. Similar technologies do not address the delays associated with varied complex modulation and buffer processing techniques between paths that are coupled with high latencies found with geosynchronous orbiting satellites operating approximately 22,380 miles in space. The latencies in each segment such as SATCOM can run as high as 250 milliseconds or more while other terrestrial elements can be measured in nanoseconds depending on the processing contribution. This system will have to account for these delays by means of buffering in order to be successful. Lastly, the energy per bit, commonly referenced to a 0 dB noise figure (written in the industry as EB/N0) can grossly impact data throughput. These power levels from path to path will vary. Some path schemes range from unusable to completely error free within a range of less than 2 dB EB/N0. The energy per bit is often not a consideration with much regard in the terrestrial solutions due to not having the additional noise contributions that comes with a SATCOM channel. The offeror will have to consider leveling techniques to ensure proper reassembly is successful. The leveling can be done in either the pre or post-transport state. The combining of multiple solutions to negotiate each of these challenges successfully will be compounded by adding versatility of providing the user the ability to program data speeds and non-symmetric distributions.

The research and development effort is comprised of two parts, the Transmitting Data Disassembler and the Receiving Data Reassembler. Specifics for the overall system includes the bandwidth usage of all paths when reassembled at the receiving end in a non-replicating distribution configuration should not consume more than 105% of the original data stream bandwidth comparatively. The means to disassemble a stream of data into 4 or more channels dealing with associated latency without adding excessive overhead is the primary technical risk. The ability to synchronize multiple inputs coming from different sources each having varied latent effects is difficult and should not be underestimated. The scope can be limited to all channels operating within any single band for the purpose of limiting the risks. A great deal of research in determining variations in path specific modulation schemes and frequencies will be required in order to solve the variation of timing of channel data departures and arrivals for reassembly.

Key specifics to the Transmitting Data Disassembler will have one input and at least four outputs. Each input and output in the Data Disassembler will be individually capable of handling a digital data stream of 19.2 Kbps through 20 Mbps (threshold). As an objective requirement, the Data Disassembler will support data rates as low as 75 bps (or lower) and as high as 512 Mbps (or more). The Transmitting Data Disassembler must be programmable by the user to distribute between 0-100 percent of the input stream to any of the output streams, to include: replicating 100% to one channel; 100% to each channel; and non-replicated, uneven distribution. As an example, the distribution percentages for a message might be broken up in the following way across four channels: 10%, 25%, 30% and 35%. The number of outputs (at least four) and their loading will be programmable by the user. A user manual will be provided.

The Receiving Data Reassembler will have one output and at least four inputs. Each input and output in the Data Reassembler will be individually capable of handling a digital data stream of at least 19.2 kbps through 20 Mbps, as a threshold requirement. As an objective requirement, the Data Reassembler will support data rates as low as 75 bps (or lower) and as high as 512 Mbps (or more). The maximum number of inputs (at least four) on the Data Resassembler will be programmable. A user manual will be provided. All reassembling will be programmable with abilities corresponding to the Data Disassembler. The total data throughput of the system will be 20 Mbps as a threshold requirement and 512Mbs, or more, as an objective requirement.

The Data Reassembler will have an equal number of inputs corresponding to the number of outputs on Data Disassembler. As a threshold, the system will use state of the art framing techniques that consume no more than 5% of bandwidth for the overhead information needed for data disassembly and reassembly (3% objective). The overhead will be used for error correction and data sequencing as necessary. The offeror is encouraged to use existing COTS error correction methods such as forward error correctional coding or preambles however if necessary, a proprietary method can be created to meet the threshold overhead requirement. Special care must be taken when designing for data disassembly due to an inherent risk of the reassembly process incorrectly reassembling the data incorrectly thus corrupting the entire data stream. The input channel data rate to the Disassembler will be equal to the output data rate of the Reassembler. The Reassembler must be able to operate successfully with path delay variations of frequency within the same band on the transmitting/receiving channels. Functional processing such as buffering, framing, and sequencing must consider associated latencies with SATCOM frequencies in the C, X, Ku, Ka and Q bands.

PHASE I: In Phase I, the contractor shall develop the architecture and design approach for the programmable digital data stream disassembler and reassembler system. The architecture and design should, at a minimum, meet the threshold requirements identified in the Description paragraph, above. Existing technologies such as inverse multiplexing and packetizing are referenced as known architectures and will not be acceptable as a phase I deliverable due to the circuit dependencies requiring feedback, bit stuffing and packetizing. The design must be state of the art and reflect agility in programmatically replicating in a non-symmetrical fashion data streams across four or more channels in a single direction and be re-aggregated at the receiving end using overhead costs within the threshold cited above. The design must show the encoding and preamble methods used on the transmission disassembly that provides a method of recovery at the receiver with means to handle the varied latencies and levels encountered in the reassembly process.

PHASE II: In Phase II, the contractor shall build, test and deliver a prototype disassembler /reassembler system in accordance with the design delivered in Phase I, including all required hardware, software and user documentation. The contractor shall develop and deliver a test methodology that includes Government approved test plan, test procedures, verification cross reference matrix (VCRM) and script files as necessary for testing. The contractor shall support demonstration testing at the Joint Satellite Engineering Center (JSEC) laboratory at Aberdeen Providing Ground for one week. The prototype system shall, at a minimum, meet the threshold requirements identified in the Description paragraph, above. The prototype will be tested with multiple data streams for disassembly and reassembly. The prototype is required to be programmable and must be able to be pre-configured by an operator to disassemble/reassemble at programmable data rates and programmable stream distribution sizes.

PHASE III: In Phase III, the Disassembler/Reassembler prototype design will be refined, optimized and productized for transition to military Programs of Record and commercial applications. All circuitry, fabrication and interfaces must utilize industry recommended or military standards (i.e.; MIL-STD-530, RS-422, etc.) wherever possible and must meet safety standards prior to delivery and labeled in accordance with best practices. The Disassembler/Reassembler system has the potential for use in multiple emerging digital transmission technologies, where there is a need for coherent data disassembly and reassembly along multiple transmission lines. Immediately, the system will provide an inherent passive Anti-Jam (AJ)/Anti-Scintillation (AS) capability which will undergo testing upon delivery. The current focus is on emerging and existing military communications systems, but this technology may also be of use in commercial areas requiring high volume data communications, including video. Military efforts such as Future Advanced SATCOM Terminals (FAST) are launching efforts to expand the digital domain in today's transponded SATCOM. Creating a means to programmatically traverse multiple polarizations offers a robust means of communications impervious to man-made scintillation and interference that if appropriately productized can be utilized throughout DoD.

REFERENCES:
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KEYWORDS: Data Stream Disassembler, Data Stream Re-assembler

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A13-031 TITLE: Enabling Dynamic Initialization Products

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a capability that enables the integration of additional Parameters into the Dynamic Host Configuration Protocol (DHCP) to automate network-parameter assignment to network devices.

DESCRIPTION: In the current and future Net Centric environment, networks operate within a meshed network architecture. Operating within such an environment requires that the basic network configuration data be accurate and compliant to network standards. This dictates the need for a single source of such data to be used in configuration and initialization of the network. The current gap within the Army force is the inability to quickly and accurately configure and re-configure the network and information systems in order to provide a robust network to facilitate command and ensure user access anytime/anywhere. In an Army environment, network initialization Data encompasses but is not limited to Unit Reference Number (URN), Internet Protocol (IP) address allocations, and Role Names. On the commercial side for DHCP static allocation, The DHCP server allocates an IP address based on a table with MAC address/IP address pairs. URN's are unique identifiers up to eight digits in length used to identify units, equipment, organizations, vehicles, and messaging groups. They can be thought of as IP addresses specific to the Service Agencies' missions; each one must be unique in order for the systems to communicate properly. As with the DHCP static allocation tying IP's with MAC addresses, URN's and role names need to be tied with IP address information. In today's environment, initialization is accomplished through non-standard processes across uncoordinated organizations while utilizing a variety of non-standard government developed stove-piped tools. The current manual intensive initialization procedures are time consuming, static, and cannot be adapted quickly to mission changes. These manual changes require a significant amount of coordination and reliance on Field support representatives. An example of a mission change that would require these types of reconfigurations would be when a Brigade commander would want to reassign Company A, which is currently tasked under Battalion A, and task organize it under Battalion B. While the change may sound simple, the tasks required to complete a change like this are intensive and need to be meticulously planned out. Mission Command systems are initialized using static IP assignments from a spreadsheet, which correlate the appropriate IP address allocations with their corresponding URN and role names. This static process results in a time consuming process to manually enter IP data into each Mission Command system in order to start up the Brigade Network as well as make Network Configuration changes. The goal of this effort is to provide timely, relevant, accurate information needed to execute their missions more effectively and efficiently by developing a capability that enables the integration of Unit Reference Numbers and role names into DHCP to automate network-parameter assignment to network devices. This would provide the ability for Mission Command systems to utilize the DHCP process upon startup to ensure that they are receiving the IP address allocation to operate. The target timeframe for initialization resulting from a mission change would be to accomplish a full reconfiguration of Mission Command systems within 1 day versus the several week process currently.

PHASE I: Identify the present state-of-the-art in Research and Development (R&D) within government, industry and academia on how best to approach this problem. Research and develop the approach for implementation. Develop an overall system design that includes specification and protocol operation. Provide a report documenting the present state of the art, the design approach, the overall system design.

PHASE II: Create a software implementation suitable for development and capability demonstration. Conduct testing to prove feasibility over operational conditions. Develop and demonstrate in a realistic environment to Product Director, Tactical Network Initialization. Deliver the prototype system to include Source code and executable with Government Purpose rights.

PHASE III: The capability could be used to provide a dynamic initialization capability to systems spanning multiple PM's/PEOs. Demonstration and feedback for integration will be guided by Product Director, Tactical Network Initialization, but ultimate transition target would likely be PM Mission Command for inclusion in the Software Block for the Battle Command Common Software Stack. This capability would have commercial applicability by possibly adding security to the Domain Naming Service Protocol and the enhancement of role based access control used in all windows based servers deployed today.

REFERENCES:
1. RFC 2131 – Dynamic Host Configuration Protocol

2. RFC 1533 – DHCP Options and BOOTP Vendor Extensions

3. CHAIRMAN OF THE JOINT CHIEFS OF STAFF INSTRUCTION CJCSI 3156.01, 10 Aug 2007, "MANAGEMENT OF JOINT UNIT REFERENCE NUMBERS"

KEYWORDS: NetOps, DHCP, URN, Role, Army, Network Initialization

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A13-032 TITLE: Common Software Foundation

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO Ammunition

OBJECTIVE: Design and development of a single software foundation that can be utilized in mobile/handheld, mounted, and command post environments. Software should be flexible enough to support a wide variety of mission needs and be extensible such that new capabilities can be added later by any development team. Intent is to develop a government owned solution, as a result preference will be placed on those solutions that do not use any proprietary or 3rd party licensed products.

DESCRIPTION: Under the Common Operating Environment (COE) the Army is executing a number of efforts targeting collapse of solutions from dozens of hardware and software foundations to a handful of Computing Environments (CEs). This is being done in order to realize cost savings through reduced redundancy and increase interoperability. Three of those CEs are the Mobile/Handheld, Mounted, and Command Post. Currently those CE's are being developed somewhat independently. It is the intent of this SBIR to design (and ultimately build) a single foundation that could be utilized across those 3 environments. This effort is different from the current execution plan of the COE because we are seeking a single software foundation that can be leveraged across all 3 domains, not 3 different foundations.

The foundation should be flexible enough so that while a common core is utilized across the 3 domains, different user interface components, varying screen sizes, and various states of connectivity (large, limited, no bandwidth) are supported. Additionally, the solution must have an associated Software Development Kit (SDK) that 3rd party groups can leverage to develop solutions.

PHASE I: Research and design potential infrastructure solutions that could meet the objectives. The team will need to gather information regarding the capabilities and mission needs of systems in each domain to ensure that the proposed solution(s) can meet those requirements.

Work with Subject Matter Experts (SMEs) from both the technical/development side as well as the tactical side to develop the concept designs.

A prototype is not required during this Phase.

PHASE II: After a selection is made on the approach, the team will implement the solution. By the end of year 1, the team will be expected to have a prototype solution in place that can work in all 3 environments and provides a limited set of capabilities. During year 2, the team will be expected to execute multiple experiments both in the lab and in operationally relevant environments to prove out the concept. The tests will not only be used to gather feedback from users, but also comments from developers with respect to the SDK.

The Phase II final report must include major issues, risks, and problems associated with the solution as well as recommended approaches to fix those items.

PHASE III: Take the product from a TRL 5 to a mature state such that it can be fielded or sold commercially. This means fixing all critical elements that were identified in Phase II, standing up a support infrastructure that can provide a mechanism for users to submit bugs and track new releases, and facilitating change requests/enhancements.

The solution developed under this topic has direct applicability to the commercial world. This product could be licensed to 3rd party developers who wish to create software applications and maximize their potential user base. Rather than develop solutions specifically for a single handheld or desktop environment, they could utilize this product to write their application once and run it in multiple commercial operating environments. This would present them with a large cost savings for development and test as well as get their product to multiple markets faster.

REFERENCES:

1. http://ciog6.army.mil/ArmyEnterpriseNetworkVision/tabid/79/Default.aspx

2. http://www.bctmod.army.mil/downloads/pdf/COE.pdf

KEYWORDS: Single Software Foundation, Common Software, Infrastructure, Mobile, Command Post, Mounted

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A13-033 TITLE: An Ad-hoc Network of Smartphones with RF Ranging Capability

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: First is to design and build an application that can form an Ad-hoc network of Smartphones in which every node can directly communicate with other nodes without routing messages through a cell tower or media access point. Second is to develop another application to compute Radio Frequency (RF) ranges between the network nodes based on the first application and communication electronics of the Smartphones.

DESCRIPTION: A future Army vision will have every soldier equipped with a Smartphone. Smartphones currently include processing, transceivers, and sensor technology that equip the user with a number of services useful to the soldier to include: communication capability (both through cell phone and Wi-Fi technology), positioning/navigation (through GPS and route planning software), and the ability to develop applications tailored to the specific soldier's function. Of particular interest to this topic is exploring the possibility of the smart phone equipped soldier to assist in enhancing situation awareness in environments where GPS is denied or provides poor quality of service.

It has been shown that if the direct distances between soldiers can be measured, these measurements can be included in forming enhanced position estimates for these soldiers. As the smart phone currently has processing, communication transceiver, and a GPS receiver, it possesses the essential components to form distance measurements between soldiers carrying smart phones and process these measurements into soldier position estimates.

The current cell phone technology will require cell tower and/or Wi-Fi infrastructure to either exist in theater or be supplied by the Army. If the Smartphone transceiver software could be modified to enable communication directly between soldiers carrying smart phones then two significant capabilities result, namely; 1) the elimination of the need for cell towers and Wi-Fi hubs and 2) the ability to measure distances between Smartphones.

The SBIR topic concept is to: 1) modify the cell phone technology concept currently existing in the Smartphone by eliminating the need for a cell tower or a Wi-Fi hub and 2) investigate means for RF ranging over the existing smart phone communication architecture. This topic will explore creating an ad-hoc network in which every Smartphone will become a networked node that can communicate to other nodes within the network without going through any cell tower or media access hub. This enables development of network exchanges expressly focused on making distance measurements between pairs of smart phones within the network. Furthermore, the range measurements can be made by a simple application that triggers the ranging to the node of interest. These measurements between

Smartphone equipped soldiers can be integrated on the smart phone to enhance the position estimates of the soldiers carrying the smart phone in the network.

Benefits to the soldier include robust situation awareness thorough improved position estimation when operating in environments where GPS is denied, degraded, or not available. The network concept when applied to communication eliminates the need to supply and maintain cell tower infrastructure in theater. One scenario, for example, is a group of soldiers having a mission to clear up a building in a remote area where there is no GPS and no cell coverage. This Ad-hoc smart phone network with ranging capability will assist them to complete their mission and reduce the casualty. Other potential applications outside the military include: emergency first responder positioning for command and control, search and rescue, and extend the cell phone communication utility in natural and homeland security disasters that disable or destroy the cell tower infrastructure.

PHASE I: Investigate feasible methods to generate an Ad-Hoc network of Smartphones and to measure distances between nodes in the network. Develop overall system design that includes specification of Smartphone Ad-Hoc networking protocol operation, and RF ranging technology.

PHASE II: Develop and demonstrate a Smartphone Ad-Hoc network where each node can directly send voice/data to other nodes in the network without the need for any cell tower or media access hub. Demonstrate Smartphone RF ranging capability based on communication exchanged between the network nodes in realistic environment. Conduct testing to prove feasibility over extended operating conditions.

PHASE III: This system could be used in a broad range of military and civilian applications where communication infrastructure does not exist, being damaged by natural disasters or destroyed by warfare activities. For example, a group of dismounted soldiers go on a mission to clear a building in a wartorn urban area where all cell towers do not function due to being destroyed or damaged. Equipping these soldiers with Ad-Hoc networking Smartphones with RF ranging capabilities will assist them to complete their mission with smaller risk of casualty. Another example, a group of first emergency responders equipped with such Smartphones will be easier to perform search and rescue mission in cases of natural disasters.

REFERENCES:
1) Mobile Ad Hoc Networks: An Evaluation of Smartphone Technologies.
http://handle.dtic.mil/100.2/ADA555594

2) Network Management System for Tactical Mobile Ad Hoc Network Segments.
http://www.dtic.mil/dtic/tr/fulltext/u2/a551968.pdf

3) Cell phone chats--in the Australian Outback?
http://news.cnet.com/8301-17938_105-20010308-1.html

4) Mobile phones without towers coming soon. http://www.smh.com.au/digital-life/mobiles/mobile-phones-without-towers-coming-soon-20110901-1jmqr.html

KEYWORDS: Smartphones, GPS, Ad-hoc network, RF Ranging, Communication.

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A13-034 TITLE: Tactical Network Configuration (NETCONF)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO Ammunition

OBJECTIVE: The objective of the Tactical Network Configuration (NETCONF) SBIR is to promote the development of applications using the emerging NETCONF standard for use within tactical wireless network deployments.

DESCRIPTION: Several of the most significant soldier needs rely upon improved and sustainable networking. Example significant soldier needs include: a) Mission Command, b) Actionable Intelligence, c) Medical Assessment and Treatment, etc. Each of these require reliable, robust, easy to operate and manage communications and information networks. Critical to performance of the networks is the development of a common and extensible configuration management capability.

Currently, common configuration management of multiple tactical radio networks is non-existent in Department of Defense (DoD) tactical networks. This results in highly complex, diverse, non-interoperable and expensive network management systems. To alleviate similar issues in enterprise networks, a new Commercial Standard called NETCONF [1] (for Network Configuration) is emerging. The purpose of this topic is to investigate, adapt and mature this emerging commercial standard for military applications due to a) the large commercial base supporting the initial development of NETCONF and b) the NETCONF framework which allows for modification/enhancements for additional capabilities and features. However, NETCONF commercial development focus is currently on operation primarily in high bandwidth, fixed infrastructure networks with stable behaviors. This is contrary to the highly dynamic, mobile, low-bandwidth and intermittent networks typical of tactical military Mobile Ad-Hoc Networks (MANETS) [2].

This effort will bridge gaps in current NETCONF technologies. Significant gaps include a) a reliance on a TCP-based transport layer with suspect performance in Mobile Ad-Hoc Networks (MANETs) [2] and Disruption Tolerant Networks (DTN) [3], b) an inability to scale to the configuration of thousands of small footprint radio devices, c) inability to push common redundant configuration code based upon a reliable multicast like capability similar to Negative ACKnowledgement (NACK)-Oriented Reliable Multicast (NORM) [4] or DTN, and d) a security model which has not been vetted by the DoD. This effort will stimulate development of a new class of NETCONF capabilities addressing the following enhancement metrics:

- Resilience to high network latency and loss,
- Decreased bandwidth consumption per managed radio (the configuration management overhead should be no more than 10% of the typical radio channel of 100 Kbps), while maintaining
- Type 3 encryption capabilities, and
- Additional authentication mechanisms, e.g., identity verification services, RADIUS authentication services or others.

The final product will be improved NETCONF Open Source code, enhanced for tactical deployments, along with supporting documentation.

This will allow the DoD to simplify management of tactical networks, leveraging the new NETCONF technology coming from the commercial sector.

PHASE I: It is expected that the product of the SBIR at the end of Phase I will be a study recommending plans for improving the NETCONF protocol, including an architecture and design approach, recommended Remote Procedure Calls (RPCs), security and transport layer, for operation in a tactical MANET environment.

PHASE II: It is expected that the product of the SBIR at the end of Phase II will be enhanced Open Source NETCONF software based upon an existing 2012 Open Source NETCONF code set, tested in a government laboratory (to be specified later), performing per the metrics previously listed and developed in accordance with new Internet Engineering Task Force (IETF) standards. Associated with the code should be documentation on its design, structure, operation and configuration.

PHASE III: During this effort, the subject technology may be applied to both commercial and military systems. Collaboration with military system developers and/or DoD personnel with systems requirements is highly encouraged.

A Phase III military transition would be the integration of this technology into, e.g., WIN-T network operations, in order to simplify configuration management and reduce costs by reducing the number of required management systems.

A Phase III commercial application would be the use of this technology in simplifying operations and management of Mobile Network applications riding on smart phones, hand-helds or vehicular network-based systems.

REFERENCES:

1. Enns, R., Bjorklund, M., Schoenwaelder, J. and A. Bierman, “Network Configuration Protocol (NETCONF)”, Internet RFC 6241, June 2011.

2. Elmasry, G., “A comparative review of commercial vs. tactical wireless networks”, IEEE Communications Magazine, Volume 48, Issue 10, October 2010.

3. Fall, K., “DTN: An Architectural Retrospective”, IEEE Journal on Selected Areas in Communications, Volume 26, Number 5, June 2008.

4. Adamson, B., Bormann, C., Handley, M. and J. Macker, “NACK-Oriented Reliable Multicast (NORM) Transport Protocol”, Internet RFC 5740, November 2009.

KEYWORDS: Configuration Management, Tactical Networks, Military Radios, MANETs

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A13-035 TITLE: Improving Battlefield System Usability

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Redesign battlefield systems to reduce the classroom training requirements, include the use of automated/embedded training tools, and make the systems highly intuitive to the user community.

DESCRIPTION: A primary goal to be achieved in the shift to the “Mission Command” concept is enabling individuals at Company and below to perform tasks that are currently being performed by staff at higher echelons. A major challenge to achieving this goal is that individuals at Company and below are not generally as well trained as staff at the upper echelon when it comes to the operation of battlefield systems employed for decision support. In addition, unlike at higher echelons the lower echelon users would not typically be using the systems in a dedicated role; most individuals are likely to be occasional and spontaneous users.

Providing classroom training for all prospective users at Company and below poses several problems:
- The logistics of training the much larger group of lower echelon users is complicated
- Individuals tend to quickly forget what they’ve been taught in the classroom unless they use it immediately and frequently
- Training material would need to cater to an audience with varying degrees of prerequisite training, abilities and job functions

This topic requires a study of current battlefield systems and recommending techniques for making them easy to learn and use by Company and below personnel. These personnel are assumed to understand their mission tasks but would not be afforded the opportunity to obtain classroom training before being asked to use a system to accomplish their task. Building automated training capabilities into the systems themselves enables:
- Training can be performed anywhere the systems are deployed, and at any time (solves logistics problem)
- Retraining at any time, focusing explicitly on aspects of systems of immediate concern to users (solves forgetting problem)
- Users can learn at their own pace; the automated training software may be developed to accommodate different experience levels and cater to different job functions or prior training typically associated with those functions (solves variety problem)

PHASE I: Recommendations on:

- How to make battlefield system user interfaces more intuitive and task focused
- Techniques for bundling user training as part of any software application
- Techniques for tailoring automated training to match the ability, experience level, task and job function of the prospective user

PHASE II: Build a new generation of battlefield systems that implement the recommendations from Phase I and could be deployed at Company Command Posts. Phase II plan should include user evaluation events as well as feedback sessions with TRADOC and Program of Record Subject Matter Experts.

PHASE III: Commercialize the solution by extending the capability beyond the tactical domain and into multiple public and private sector software solutions. System should be designed to ensure that it can be applied to multiple domains with little modifications.

REFERENCES:
1. http://www.ausa.org/publications/ilw/Documents/TB_The_Squad_web.pdf

2. http://www.atsc.army.mil/tsaid/IntegrationDiv/embeddedTrg.asp

KEYWORDS: Training, Mission Command, cognitive system, embedded training

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A13-036 TITLE: Vehicle Mounted LIDAR Standoff Roadside Hazard Detection

TECHNOLOGY AREAS: Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Design and develop the algorithms needed to detect emplaced roadside hazards under vegetative cover using LIDAR range and intensity data.

DESCRIPTION: LIDAR sensors produce an active laser pulse in a linear scanning pattern sweeping across its field of view. These pulses reflect off of the various objects and surfaces present in a given scene. Once processed the LIDAR pulses form a "point cloud" representing the 3D orientations of objects and surfaces within the scene. LIDAR sensors are known to have the capability to detect objects and surfaces partially occluded by vegetation of varying density levels. This SBIR will develop algorithms to detect roadside hazards using this 3D LIDAR point cloud.

PHASE I: The Phase I goal is to demonstrate techniques and concepts that could be used to detect targets beneath a layer of light to medium vegetative brush. To support development of these algorithms the contractor must collect LIDAR data on targets of interest under light to medium vegetative cover. The concepts and techniques to be leveraged in Phase II (e.g. range, intensity, texture, spin features, etc.) will be demonstrated to and validated by government Subject Matter Experts (SMEs). Fully autonomous algorithms are not required during this phase.

PHASE II: The Phase II goal is to develop fully autonomous algorithms for detecting targets. The algorithms developed in this phase will be based off of the approaches demonstrated in Phase I. In addition to developing the Aided Target Recognition (AiTR) algorithm, a change detection algorithm will also be developed. The change detection algorithm will be developed to discard false-alarms created by objects previously rejected as targets by the operator. The change detection algorithm will be capable of notifying the operator to the presence of a new target.

The Phase II final report must include a separate estimated probability of detection for targets with no, light, and medium vegetative cover as well as an overall false-alarm rate. The report must also include an analysis of the probability of detection and false-alarm rates and recommendations for future system and algorithm improvements.

PHASE III: Take the algorithms from a TRL 5 to a mature state such that they can be fielded or sold commercially. This includes the system and algorithm improvements described in the Phase II report. These algorithms could then be fielded for use in detecting roadside hazards during military operations or for detecting roadside hazards or other structures of interest under vegetation overgrowth by city planners and utility/highway inspectors.

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KEYWORDS: LIDAR, target detection, AiTR, roadside hazards, algorithm development, pattern recognition, ATR

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A13-037 TITLE: Compact Full-Framing Hyperspectral Sensor for On-The-Move Ground-to-Ground Applications

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Develop a hyperspectral sensor that can provide high resolution, on-the-move, actionable information to the user in a relevant amount of time. The sensor should be capable of continuous mobile operation from a vehicular platform.

DESCRIPTION: Hyperspectral sensors have demonstrated the ability to provide remote sensing utility and actionable information to the warfighter. Currently deployed airborne hyperspectral platforms utilize state-of-the-art sensors combined with near real-time processing to generate detection products in minutes. Extending this functionality to the ground-to-ground (G2G) scenario however presents a different set of challenges including the lack of a steady forward motion for 'pushbroom' type scanning, a highly variable vibration environment, different SWAP-C (size, weight, power, & cost) trades, and the need for processed result products in near real time. In this SBIR, a potential offeror should develop a ground based, vehicle mounted hyperspectral system for investigation of targets while performing on-the-move operations. The sensor should at a minimum cover the VNIR & SWIR portions of the EM spectrum from a threshold of 700-1600nm and an objective of 400-2350nm with enough spatial resolution and spectral bands to discriminate current target threats from various tactical background scenarios. Solutions that could also be implemented in the LWIR are preferred, though not required. Targets are assumed to be relatively small in spatial extent (~0.5m) and sufficient standoff (>30m) is required to stop the vehicle before overrunning a suspected target when moving at current operational rates of advance.

PHASE I: Model the proposed system, taking into account potential user feedback in order to determine key sensor design parameters including number of bands, spatial resolution, required optical throughput, and anticipated signal-to-noise ratio (SNR) at each wavelength. Analyze anticipated temporal latency in the proposed system in order to determine anticipated time between image acquisition and presentation of results to user. If possible, demonstrate in a laboratory or benchtop configuration a scaled model of the spectrometer system.

PHASE II: Construct the proposed system developed in phase I. System shall be built, calibrated, tested in the laboratory, and evaluated in a field trial during phase II. Testing shall be conducted against targets or target surrogates relevant to the problems facing the warfighers in the active military theater.

PHASE III: In a phase III effort, the system shall be ruggedized for fielding in a theater-relevant environment. In addition, transitional opportunities will be identified in the non-military area. These may include geological mapping, border surveillance, and entry control point security.

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6. Recent Advances in Mobile Ground-Based Hyperspectral Detection of IEDs, Home Made Explosives, and Energetics-Related Materials., Yasuda et. al., Military Sensing Symposium on Battlefield Survivability and Deception. (March 2012).

KEYWORDS: hyperspectral, spectrometer, spectra, countermine, situational awareness, on-the-move, spectral processing, real-time

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A13-038 TITLE: Intelligence Requirements Management (IRM)

TECHNOLOGY AREAS: Information Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The contractor shall design and develop an Intelligence Requirements Management (IRM) system with the ability to generate, track, and maintain the Intelligence Requirements from the Mission statement to the Commander’s Intent, to the Commander's Critical Information Requirements (CCIRs), to the Priority Intelligence Requirements (PIRs), Essential Elements of Information (EEFI) and Friendly Force Information Requirements (FFIRs). The system should include the ability to create Decision Points. Decision Points consist of a decision and two or more alternative actions, triggered by the answer to the CCIR. The system needs to provide the capability to initiate intelligence collection, monitor the status, and notification of collected information by interoperating with existing and future ISR Synchronization tools.

DESCRIPTION: An IRM system provides the ability to generate, track, and maintain to the original intelligence requirements in the Mission Statement, Commander's Critical Information Requirements (CCIRs), Priority Intelligence Requirements (PIRs), and Friendly Force Information Requirements (FFIRs) during the Military Decision Making Process (MDMP) as the basis for their analysis and conclusions. The system should include Decision Points that trigger the alternative actions and the ability to rewrite the CCIR to be as specific as possible in order to make the execution of the Decision Point unambiguous based on the information received from the collection unit. The system needs to provide a feedback capability to the Commander and staff on whether the requirements have been met or not met based on the information received from the collection unit. The IRM system needs to provide the capability to initiate intelligence collection, monitor the status, and notification of collected information by interoperating with existing and future ISR Synchronization tools.

The IRM system may use intelligent systems algorithms to improve system efficiency in the following areas:
1) checking for logical inconsistencies, 2) identifying duplication of requests, 3) tracking data and information flows, 4) identifying cognitive biases, 5) predicting a commander's interpretation of intelligence reports, 6) determining causal relationships between information requests and commander's intent, 7) correlating disparate information sources, 8) tracking combat performance as a measure of the efficiency of the intelligence system, 9) identifying and storing decision points, 10) determining possible and actual enemy countermeasures, 11) recording workload and delays in the work flow, and 12) suggesting alternatives or modifications to actions, information requests, or even the statement of intent itself. These algorithms could be based on one or more intelligent system methods such as statistical pattern recognition, neural networks, fuzzy logic, possibility theory, artificial evolution, optimization theory, cognitive psychology, or traditional artificial intelligence. However, it is not the intent of this Topic to force the researchers to select any of the particular approaches and these are just examples that may be utilized.

PHASE I: Perform a design study to formulate innovative technical approaches to develop an IRM system that offers an enterprise solution that works within the Army Command Post Computing Environment architecture, which is based on virtualization, rich web client (Ozone Widget Framework), and data analytic cloud. The design study should define the paradigm for customizable and evolving applications that interoperate with existing and future ISR Synchronization tools. Complete an IRM system design concept and demonstrate through modeling, analysis or prototype that it meets the requirements.

PHASE II: Use the results of the design concept generated in Phase I to develop a software prototype of the IRM system for use with ISR applications and with existing and future ISR Synchronization tools. Use the software prototype of the IRM system to perform a demonstration that validates that the approach improves traceability of Intelligence Requirements and operational effectiveness.

PHASE III: Implement the IRM system as part of the DCGS-A/JUMPS systems and deploy the system for test and evaluation using commercially available technologies. The implementation should ensure that the system is interoperable with existing and future Synchronization Tools. Potential applications include special operations forces missions, maritime domain awareness, and border security missions.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Technologies developed are directly applicable to law enforcement and homeland security missions including border patrol and counter narcotics missions.

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KEYWORDS: Intelligence Requirements Management, Intelligence Requirements Cycle, Intelligence, Surveillance, Reconnaissance,

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A13-039 TITLE: Amplifier Linearization Module

TECHNOLOGY AREAS: Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective of this SBIR is to design, develop and build a prototype linearization module which can be incorporated/attached into a commercial-of-the-shelf (COTS) RF amplifier with no modification.

DESCRIPTION: Many military programs/systems use commercial-of-the-shelf (COTS) products in their design, including RF amplifiers. However, these amplifiers commonly produce spurious emissions (2nd harmonic, 3rd order intermodulation, etc) due to their wideband, high power and lower cost nature. In highly sensitive, state of the art military systems this can present a problem; this is especially an issue during laboratory based R&D efforts. It is desired to have a modular solution which can be attached to a COTS amplifier with no modification which will remove, or at least greatly reduce, these spurious signals so that the amplifier can be driven near it's compression point (to maintain efficiency) but not suffer from non-linear spurious signals. This could be accomplished through various methods and there is no preference to the method used; either a software or hardware based approach is equally acceptable. The solution needs to be compatible with high power amplifiers (~200W), provide wideband performance (~1GHz) and be operable in the VHF, UHF and low microwave (100MHz-2GHz). The system should be compact and low power to not overly increase the requirements of laboratory setups or systems. The contractor should design a system and provide a technical discussion of why it will be successful for removing/suppressing spurious signals.

PHASE I: The contractor shall conduct a feasibility study to develop a compact amplifier linearization module which can improve non-linear spurs from commercial RF amplifiers. The contractor shall submit a report which shall detail the results of the feasibility study of the system to be used to perform this mission. The report should contain a description of the system, as well as technical details of how the system will perform the required task(s) and expected performance. A brief high level plan for phase II work should be included in this report in the event of a phase II selection.

PHASE II: The contractor shall develop a robust prototype system based on the results of the Phase I effort. The prototype system will be able to be attached to a commercial amplifier and demonstrate an ability to remove and/or improve the spurs present in the output of the amplifier caused by non-linear affects of the amplifier. A demonstration of the system will be done at a location determined by the government.

PHASE III: Based upon Phase II results the system will be improved upon and optimized for commercialization. Multiple military programs and commercial applications can benefit from this system including: R&D laboratories, cell phone providers, and electronics developers/manufactures.

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KEYWORDS: linearization, RF amplifier, non-linear, spur, module

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A13-040 TITLE: Electro-Optically Guided Radar Imaging

TECHNOLOGY AREAS: Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop an electro-optically guided high resolution MMW radar imaging method with enhanced information processing capability.

DESCRIPTION: MMW radar imaging is commonly employed for high resolution terrain mapping and surveillance, as well as for concealed threat detection methods. However, the majority of the scanning methods currently employed utilize mechanically scanned apertures, which significantly inhibit the amount of time required for image generation.

Motion-free beam steering is particularly attractive, namely because of advantages in reliability, as well as the ability to permit rapid and gross changes in scanning directionality, which ultimately enables flexible scan patterns and the ability to pan to specific points of interest.

Two common methods of motion-free beam steering are phased-array antennas, and reconfigurable-plasma refraction antennas. However, as a consequence of the sheer number of components involved in phased-array beam steering approaches, these methods are typically excessively complex, as well as cost-prohibitive. Consequently, a more favorable approach would be to use a lightweight, efficient, optical front end to perform the beam steering.

Recent investigative studies utilizing the transient Fresnel zone plate approach, where a spatially varying density of charge carriers is created by optical injection of plasma into a semiconducting wafer, have been demonstrated. While this methods shows promise as a potential solution to enabling high resolution, motion-free scanning, it is still inhibited by information processing limitations.
In order to improve upon current image resolution thresholds, increased bandwidth is desired beyond 600MHz and objectively up to 3GHz. However, the increase in bandwidth reciprocally increases the challenges faced in processing information. Traditional radar information processing strategies employ range bins, as a data sampling method. Such techniques are necessitated in order to increase data processing efficiency, however, the consequence of this is diminished image resolution.

The proposed effort will be designed to mitigate the impact of the loss in image resolution as a consequence of data sampling in the RF spectrum, by frequency up-converting the detected RF. Assuming the signal integrity can be maintained throughout, data sampling may then be achieved through the insertion of an ultra-fast optical shutter (e.g. Pockels cell) or other means. The method must also be compatible with an optical beam steering architecture so that it may be implemented in later phases.

PHASE I: The proposed effort will experimentally demonstrate proof-of-concept. Expectations for Phase I, will be to successfully frequency up-convert radar target energy in the mmW band, to an optical band, and verify that the signal characteristics may be preserved at the detection end-state, following transmission through the selected sampling method. A final report on the investigation and demonstration will be provided to the Government.

PHASE II: Expectations for Phase III, will be to expand the prototype to a producible configuration and look to apply the technology to military applications such as assisting with degraded visual environment (DVE) helicopter landings. Some commercial applications consist of law enforcement, home-land defense, and hand-held devices for screening of materials (i.e. civil construction, packages, etc.). A transition to operational capability could be applicable to all military rotary-wing applications and missions.

PHASE III: Expectations for Phase III, will be to expand the prototype to a producible configuration and look to apply the technology to commercial uses such as, law enforcement, home-land defense and hand-held devices for screening of materials (i.e. civil construction, packages, etc.)

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KEYWORDS: antenna, radar, radar imaging, electro-optical

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A13-041 TITLE: Signal Recognition and Management Band Pass Filter (BPF) Devices

TECHNOLOGY AREAS: Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: To develop Signal Recognition and Management Band Pass Filters (BPFs) that can parse out desired signal(s) from unintentional and/or intentional interference signals that are present in our RF jammers, sensors, and communications receiver channel(s) while maintaining capability to tune out all out-of-band interference signals from the receiver channel(s) of interest. These devices will be installed in-line between the antenna and the RF receiver of jammers, sensors, and communications systems.

DESCRIPTION: The US Army has a requirement to assure unimpeded voice and data flow in RF jammers, sensors, and communications systems within the integrated C4ISR network system. Specifically, the Signal Recognition and Management Band Pass Filter (BPF) device will be designed and fabricated to perform the following functions.

First, the Signal Recognition device will parse out signal(s) of interest from unintentional interference signals such as EMI, RF harmonics of friendly communications systems, and friendly jamming signals as well as intentional interference such as enemy jamming signals that are present in receiver channels of our jammers, sensors, and communications systems. In-pass interference separation objective will be 50 dB which is the degree of separation between designed signal(s) and interference.

Second, the BPF devices will retain the traditional function of rejecting out-of-band interference signals to selected receiver channels. The minimum out of band rejection ratio will be 70 dB. The minimum passband bandwidth will cover the receiver channel for all jammers, sensors, and communications systems. The passband bandwidth, passband ripple, and transition frequency ranges will be set for optimum performance. These BPF channels will be programmable.

Finally, the BPF devices will be capable of rapidly tuning its band pass filters to cover frequency hopping radios and rapid scan ELINT operations from interference signals. Tuning speed will be at 250 ns or less including settling time.

RF frequency range for these devices will cover the RF frequency spectrum from HF to microwave. Minimal SWAP will be seriously considered with the BPF device size, weight, and power consumption being less than .10 ft3, 1 lb, and tens of Watts respectively. The production device will be installed in-line between the antenna and the RF receiver of jammers, sensors, and communications systems.

PHASE I: Conduct a feasibility study that identifies and addresses the problems that must be overcome in order to successfully parse out the desired information signal(s) from interference signals that are present in RF receiver channels. Develop system design and architecture as well as performance specifications for the Signal Recognition and Management BPF device at TRL 3. Deliver final report that covers the outcome of this study, system performance specifications, and system design and architecture development.

PHASE II: Fabricate a laboratory prototype device to test and demonstrate/validate the feasibility of parsing out desired signal(s) from interference under controlled laboratory and/or anechoic chamber conditions. Field testing will be performed at Government facilities to assess operability and reliability of this device under rugged conditions. MIL-STD-810G will be used as a guide for field testing. The TRL 5 prototype device, its description and operations report, and test reports will then be delivered.

PHASE III: Develop Signal Recognition and Management BPF TRL 6 devices that will transition to all RF receivers within PEO IEW&S and PEO C3T jammers, sensors, and communications systems, specifically PM EW, PdM CREW. These devices can be applied domestically by police, FBI, and Homeland Security to parse out and/or secure information signals of interest (e.g., terrorist transmission, police radio transmission, etc.) in a noisy environment. These devices can be also used by search and rescue teams to detect distress calls that would otherwise be masked in a noisy environment.

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2. http://arxiv.org/pdf/0802.1343 Impedance-Matched Low-Pass Stripline Filters

3. http://eceweb1.rutgers.edu/~orfanidi/osp2e/osp2e.pdf Optimum Signal Processing, An Introduction

4. http://www.dtc.army.mil/publications/milstd.aspx, then click on “MIL-STD-810G”, MIL-STD-810G (Environmental Engineering Considerations and Laboratory Tests)

5. http://peoiews.apg.army.mil/ then click on “PROGRAMS”

6. http://peoc3t.army.mil/c3t/

KEYWORDS: Band Pass Filter (BPF), Signal Parsing, Signal Recognition, frequency hopping, SWAP, ELINT

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A13-042 TITLE: Improved performance of small pixel infrared detector focal plane arrays via in situ mesa sidewall characterization

TECHNOLOGY AREAS: Electronics

OBJECTIVE: Demonstrate a process capable of in situ sidewall characterization allowing timely feedback for the development of processing and design modifications to improve small pixel infrared FPA performance.

DESCRIPTION: Meeting the Army's need to reduce the size, weight, and power requirements, while increasing the performance of infrared detectors, requires the fabrication of smaller FPA pixels. As the sizes of pixel mesas are reduced, leakage currents from mesa sidewalls become a much greater factor, especially in long and very long wavelength detectors. Small pixel infrared detectors will require passivation of etched sidewall surfaces to achieve higher sensitivity. The lifetime of these detectors or arrays will greatly rely on the long-term stability of the passivated surfaces.

It is well known that surface chemistry and morphology play a major role in determining the electrical properties at the semiconductor air interface. However it is progressively more challenging to characterize the sidewall chemical and morphological properties as diode mesa dimensions are reduced to near wavelength dimensions. The ability to characterize these sidewalls in a timely and nondestructive manner will enable the further improvement of processing techniques and the development of robust passivation treatments. This topic solicits innovative ideas for in situ surface characterization techniques that would enable the development of improved sidewall passivation treatments. The proposed technology should have broad range of material applicability to include II-VI and III-V based devices and respective passivation materials.

PHASE I: Develop a theoretically valid design for an instrument capable of in situ chemical analysis and morphology measurements of mesa sidewalls with angles > 80° and heights ranging from 1 micron to 10 microns in a nondestructive manner. The proposed innovative design must be viable for implementation in phase II. The techniques may include but are not limited to combinations of Raman spectroscopy, Photoluminescence spectroscopy, capacitance-voltage measurements, and surface probe microscopy (SPM).

PHASE II: Optimize and implement the design developed in phase I by constructing a prototype instrument. Demonstrate the in situ characterization capabilities of the instrument on III-V and II-VI based long wavelength infrared detector mesas meeting the criteria set forth in phase I. Deliver the prototype instrument for testing.

PHASE III: An instrument capable of sidewall characterization (in situ) allowing timely feedback for the development of processing and design will enable the manufacturing of high performance infrared focal plane arrays for improved targeting and detection. By improving the understanding of small pixel sidewalls could enable new commercial applications such as sensor arrays for high-resolution medical imaging, navigation, and fire/rescue aid. Demonstrate equipment at major semiconductor conference exhibitions.

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KEYWORDS: Semiconductor, Surface Chemistry, Spectroscopy, Instrumentation, Infrared detector.

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A13-043 TITLE: Ordered Packing and Efficient Aerosolization of Anisotropic Particles

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Demonstrate a novel system of packing and dissemination for discs or fibers with a major dimension of a few microns and minor dimension of tens of nanometers.

DESCRIPTION: Smokes and obscurants play a crucial role in protecting the Warfighter by decreasing the electromagnetic energy available for the function of sensors, seekers, trackers, optical enhancement devices and the human eye. Recent advances in materials science now enable the production of precisely engineered obscurants with nanometer level control over particle size and shape. Numerical modeling predicts that order of magnitude increases over current performance levels are possible if high aspect-ratio conductive particles can be effectively disseminated as an unagglomerated aerosol cloud.

One of the fundamental challenges in maximizing the performance of obscurant devices is the method of packing and disseminating high aspect-ratio conductive obscurant particles. In current devices, a pyrotechnic or explosive center burster is used to disseminate a powder contained in a surrounding cylinder. Compacting the obscurant fill powder increases the quantity of powder that can be delivered by the device; however, this compaction process can result in the production of particle agglomerates that are much less effective than individually aerosolized particles.

Packing and dissemination cannot be performed in isolation; they are intimately linked. Novel technologies are sought that will allow high fill fraction packing of anisotropic conductive flake or rod particles. When disseminated, the particles should readily separate from each other into a well dispersed aerosol cloud. Effective formulations may require surface modification to the particles, the addition of compounds that increase dispersibility, or an ordered arrangement of particles. Alternative device configurations that create microturbulence (on the order of particle major dimension) during the dissemination process may also be effective in separating particle agglomerates.

PHASE I: Demonstrate novel methods of organizing high aspect-ratio obscurant powders into a cylindrical geometry at a high fill fraction (>40%). Demonstrate that the organized powders can be readily dispersed with minimal agglomeration(>40% single particles of original size). Provide samples for testing at ECBC chamber.

PHASE II: Demonstrate that particle production and packing techniques can be scaled up to 200-g scale and that performance advantages are retained when aerosolized. If Phase I demonstrated concept with flakes, repeat with microfibers, or vice versa. Provide samples to validate results at ECBC chamber.

PHASE III: The techniques developed in this program can be integrated into current and future military obscurant applications. Improved grenades and other munitions are needed to reduce current logistics burden of countermeasures to protect the soldier and his equipment. Improved dissemination techniques can be beneficial for all powdered materials in the metallurgy, ceramic, pharmaceutical and fuel industries. Industrial applications include electronics, fuel cells, batteries and solar energy.

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KEYWORDS: discs, fibers, ordered packing, obscurant, aerosolization, agglomeration

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A13-044 TITLE: Development of advance obscurants materials using synthesis of metallic hollow nanoparticles

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a low cost obscurant material utilizing metallic hollow nanostructures. With novel synthesis and chemical reactions, these nanostructures will take on strong surface plasmon resonance (SPR) effects that exhibit negative index material. Most common plasmonic materials are gold and silver, however, there are many other materials that show metal like optical properties can be explored to lower costs. Researchers are encourage to look for cost saving alternatives to gold and silver, with the goal to drive costs lower than silver processing costs. Processes such as Sequential Galvanic Exchange and Kirkendal growth at room temperatures have shown to produce very unique metallic structures with intriguing optical and mechanical properties. Unique forms of intermetallic coupling and formation of cavities between layers generate surface Plasmon resonance peaks that can be tunable from the visible to the near-infrared region. This method has been successfully applied to prepare gold, platinum and palladium based hollow nanostructures with a wide range of different morphologies, including cubic nanoboxes, cubic nanocages, triangular nanorings, prism-shaped nanoboxes, single-walled nanotubes, and multiple-walled nanoshells or nanotubes. Morphological transformation of refluxing silver with HAUCl4 creates gold/silver alloyed shell structures could offer a cost savings approach. The optical effects of impurities in the system are unknown to the author for these metallic structures. Size distribution for traditional materials plays an important role in obscurants. Based on the index of refraction, specific sizes and shapes are most efficient at obscuring targeted specific areas of interest (reference Janon Embury's report). Since plasmonic materials have unusual behaviors for the index of refraction, these properties would need to be researched to see if similar optimizing effects are present.

DESCRIPTION: Smoke and obscurant materials are used by the Army to protect both the individual soldier as well as military assets such as tanks and aircraft. Recent advances in sensors, seekers and trackers are demanding for more efficient and better performing obscurant counter measures in both the visible and infrared regions. With the advancement of portable electronic systems, the soldiers in small units are overburdened, having less available space for carry tradition smoke devices. More efficient devices are needed to provide adequate protection to the soldier.

Metal nanoparticles are being investigated in considerable detail due to their exciting potential for application in catalysis, biological and chemical sensing, optoelectronics and magnetic memory. Nanoparticle shape plays a crucial role in determining optical and electronic properties, and the ability to control the nanocrystals has lead to the first observations of plasmon resonance modes in silver nanoprisms. In addition to anisotropic nanostructures, there is also considerable interest in the synthesis of nanoscale structures consisting of a core of one chemical composition covered with a concentric shell of another material in what is commonly known as the 'core–shell' configuration. These configurations have shown very unique optical properties without having the high conductivities associated with traditional metal flakes that are used to reduce infrared electromagnetic signatures.

In addition to plasmonic optical properties of these metallic nanostructures, hollow cores will aid in the buoyancy of these particles. Current obscurant materials tend to have high deposition rates. Lighter, hollow core metallic have the potential for staying airborne for much longer periods of time.

PHASE I: Develop and synthesize various metallic nanostructures, both an anisotropic and core-shell structures and measure the ability to obscure electromagnetic energies. Most of this research has been based on solution based chemistry. Traditional characterization of these types of materials have been in wet cell spectroscopy. For the infrared (IR), nujol measurements have been used. Novel characterization methods are encouraged to determine effectiveness of engineered shapes on various areas of the electromagnetic spectrum.

The primary focus of this effort is to provide proof of concept that these metallic nanostructure materials can provide an effective obscurant and determine which shapes best attenuate the wavelengths of military interest. With current threat systems, four basic areas of interests are identified. For visual; 0.4 to 0.7um, for near IR 0.9 to 1.5um , for mid IR; 3 to 5um, for long IR; 8 to 12um. For a material to warrant continued investigation for a Phase II effort, this material must be able to efficiently absorb or scatter electromagnetic energy better than our current standard materials. For infrared screening materials, brass powders are used having an efficiency extinction of approximately 1.4 m2/g. For visible screening materials, Titanium Dioxide powers are used having an efficiency extinction of approximately 4.5 m2/g.

PHASE II: Continue with cost effective scale up material development and fabrication. The ultimate goal for this material is to make an aerosolized cloud that can be deployed quickly between an incoming threat and the equipment and personnel being protected. That generally involves some type of dissemination system involving dry materials. During phase II, processes and methodologies will need to be investigated to make dry powders from the materials that were developed in Phase I. In addition, developing novel ways to aerosolize these materials by minimizing particle to particle agglomeration. Perhaps some kind of microturbluance systems could be employed, either pyrotechnically or pneumatically. Several concepts should be investigated to effectively pack these materials and fabricate device to disseminate this packed system.

PHASE III: The techniques developed in this program can be integrated into current and future military obscurant applications. Improved grenades and other munitions are needed to reduce current logistics burden of countermeasures to protect the soldier and his equipment. Improved dissemination techniques can be beneficial for all powdered materials in the metallurgy, ceramic, pharmaceutical and fuel industries. Industrial applications include electronics, fuel cells, batteries and solar energy.

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KEYWORDS: obscurant, aerosolization, agglomeration, metal nanostructures, core-shell, anisotropic, plasmon resonance

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A13-045 TITLE: Battle Fuel Conditioner (BFC) for Commercial Gas Appliances in Field Kitchens

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a technological solution for safely, reliably, and effectively utilizing battlefield fuels in commercial off the shelf gas-fired appliances in military field kitchens.

DESCRIPTION: An objective of modern military field kitchens is to provide cooks with high quality, effective appliances to maximize capability, throughput, and flexibility to prepare the entire family of operational rations. The Army's legacy JP-8 fired appliances fall short, relying on inefficient burner units that subject cooks to excessive heat, exhaust, and noise. There are several possible solutions, including modernized JP-8 appliances and commercial appliances. Other Research and Development (R&D) efforts are developing improved JP-8 kitchen equipment, but will result in military-unique or highly modified commercial appliances with less than certain supportability. Commercial electric appliances are very effective, and have been employed in the Army's Force Provider kitchens and some Air Force kitchens. However, electric appliances are very power-hungry, and electricity comes at a high price for small contingency bases, where it is typically generated from JP-8. This is at odds with a pressing need to reduce the logistic burden of deployed forces and contingency bases, including energy and fuel.

Commercial gas appliances are attractive from supportability, reliability, and energy cost perspectives if there were a way to fuel them, but bottled gases will never be considered a battlefield fuel. The purpose of this BFC topic is to address this challenge and improve the logistics of field feeding while providing military units additional flexibility with respect to meal preparation, appliances, and fuel sources. As an operational concept, BFC equipment is envisioned as relatively small devices, paired individually with a gas appliance, that convert battlefield fuel from an onboard supply into a gas that burns cleanly in the appliance. Target appliances include griddles, ovens, combi-ovens, and hot plates. Pairing one BFC device with each appliance promotes overall kitchen availability versus a single fuel conditioner for the entire kitchen, facilitates quick replacement with spares in the event of malfunction, and allows appliances to be more easily removed from the mobile kitchen platform and installed into a more permanent facility. It is expected that the appliances would be easily reconfigured for liquefied petroleum gas (LPG) when it happens to be locally available in theater. Substantial fuel savings are expected compared to electric appliances powered by tactical generators.

The BFC shall convert battlefield fuel into a gas or mixture that can be used directly in commercial gas-fired kitchen appliances with minimal modification (e.g., pressure regulation, orifices, fuel/air mixer). The BFC output must burn cleanly and safely in the appliance. BFC devices must be able to reliably start, stop, and modulate or turn down as necessary for their paired appliances, and should be suitable for hot and basic climates (-25 °F to 120 °F). Although fuel conditioning technologies are not mature for this scale or application, several candidate technologies have been demonstrated for JP-8 in fuel cell applications. Technological approaches include, but are not limited to, catalytic cracking, autothermal reforming, partial oxidation, and cold plasma reforming. One potential challenge for this application is the significant difference in Wobbe Index between LPG and typical syngases. Recognizing that trade-offs may have to be made, the following characteristics are desirable: minimal procurement cost (objective less than $1K) and size (objective less than 3 cubic feet per appliance), low power requirements (objective less than 50 W per 10,000 BTU/h gas output), good conversion efficiency (objective more than 60%), minimal modifications to appliances, high reliability, low maintenance, partially or fully self-powered operation, ability to integrate with a wide variety of appliances, and quick replacement with spares.

PHASE I: Establish the technical feasibility of a system concept that meets the operational requirements stated in the topic description by conducting research to demonstrate that the approach is scientifically valid and practicable. Mitigate risk by identifying and addressing the most challenging technical hurdles in order to establish viability of the technology or process. Perform proof-of-principle validation in a laboratory environment, and characterize performance (including BFC output characteristics, conversion efficiency, power requirements, starting and stopping, turndown, longevity, gas interchangeability, and cold weather suitability) through experimentation with JP-8 fuel (or Jet A-1 as an acceptable surrogate) and representative gas burners. Address supportability, safety, and human factors concerns, and provide credible projections of size, weight, cost, and performance of a system suitable for fielding.

The Phase I proposal shall detail a specific approach leading to a tangible proof of concept (i.e., it shall not be a paper study). It should provide performance metrics, including mass and energy balance, of current and projected capabilities, and key claims should be strongly substantiated, including citations, to ensure credibility. The Offeror should demonstrate knowledge and expertise closely related to the proposed work.

PHASE II: Refine the concept and fabricate a prototype system(s) that meets the operational requirements stated in the topic description and is sufficiently mature for demonstration, limited field-testing, and display. Develop with attention to safety and human factors and consideration for manufacturability. Demonstrate integration and successful operation with multiple commercial gas appliances. Deliver the prototype(s) with operating instructions and safety documentation to enable Government demonstration of the technology in a relevant field kitchen environment.

PHASE III DUAL-USE APPLICATIONS: The initial military application for this technology will be battlefield fuel conditioning system that facilitates efficient and supportable multi-service field kitchens, contributes to simplified acquisition, and provides the Warfighter with effective, efficient, and high quality gas appliances. The transition from research to operational capability will involve technology demonstration at representative sites, follow-on development work in coordination with Army Product Manager Force Sustainment Systems, and ultimately fielding as components of field kitchens. Potential commercial applications are more difficult to predict, but there are a number of potential spin-off applications for diesel and aviation fuel reforming, such as for powering fuel cells, reducing wetstacking in diesel generators, and using diesel in spark ignition engines.

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1) Detail Specification MIL-DTL-83133 - Turbine Fuels, Aviation, Kerosene Types, NATO F-34 (JP-8), NATO F-35, and JP-8+100 (https://assist.daps.dla.mil/quicksearch/basic_profile.cfm?ident_number=33505)

2) DoD Food Service Equipment & Field Feeding Systems
(http://nsrdec.natick.army.mil/media/print/FSE_3ED.pdf)

KEYWORDS: Keywords stayed the same: battlefield fuel, logistics fuel, JP-8, diesel, field kitchen, gas appliances, cracking, reforming, syngas

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A13-046 TITLE: Self Contained/Self Powering Solutions for Protective Eyewear Employing Active Lens Technologies

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop self-powering solutions for protective eyewear (spectacles and/or goggles) that employ an active means of variable light transmission (i.e., an active means of achieving a clear and sunglass state in a single lens system) in support of Soldiers, Marines and other service members who require the use of active lens technologies.

DESCRIPTION: Variable transmissive lenses are in the process of being developed to provide eye protection that can rapidly adapt to changing light conditions, such as those experienced while moving in and out of buildings. Solutions with the most rapid transition from clear to sunglass state, and vice-versa, are power driven. Passive based alternatives (i.e., photochromic lenses) transition too slowly in rapidly changing lighting conditions (such as moving in/out of buildings) and tend to rely on the presence of ultraviolet radiation in order to change from clear to sunglass states (reducing effectiveness when worn in vehicles).

Power requirements present a challenge in the field, due to the need for replenishment. This SBIR effort serves to focus on developing small-scale self-contained power solutions suitable for spectacle and/or goggle formats, with the goal of a continual means to replenish the power needed for active lens technologies when a means of physically charging the eyewear by other means is not readily available. The unit should be self-contained within the eyewear platform such that no tethering to the powering unit is required. Designs may consider utilizing existing eyewear components, such as the lens itself, as a power generating component. The effort is intended to benefit Soldiers, Marines and other service members who require active eyewear to be worn in remote locations for extended periods of time.

PHASE I: Phase I shall focus on designs for integrating self-powering technology capable of supporting the power requirements of a spectacle and/or goggle employing active (powered) variable transmission lens technology. Designs using currently approved US military protective eyewear as the platform for demonstration are preferred. Designs should consider the amount of power required by typical active lens systems, and ultimately be capable of supporting these systems on a continual basis in a military environment. This includes use on overcast days and other low-light level conditions. Consideration should also be given to other end item eyewear requirements, (reference GL-PD 10-12, Purchase Description for Military Combat Eye Protection) including, but not limited to:
- function reliably in varying climatic conditions (such as hot, cold, rainy, dry, salt water, etc. environments)
- meet military ballistic fragmentation impact, as well as ANSI Z87.1, requirements (optics, impact, etc.)
- be compatible with military helmets

Integration of the self-powering technology shall balance weight and not adversely impact ability to retain the eyewear on the head (such as may result from a front-heavy design). Designs shall be sufficiently durable to survive use in a military environment, and not introduce features that may snag in the field. Cost and manufacturability shall also be considered up-front.

During Phase I, current electrochromic and liquid crystal variable transmissive protective eyewear devices in development and production will be surveyed and power requirements identified. A variable transmissive eyewear system will be chosen to work with, and a corresponding self-powering device subsequently designed to support the power requirements of that system on a continual basis without the need to recharge. Self-powering designs should target/leverage the existing real-estate of the eyewear product selected. The design shall be characterized/verified by means such as modeling, breadboard prototyping and testing. Characterization shall include, but not be limited to, the goals/metrics outlined below. Detailed monthly progress reports shall be provided, as well as a final report detailing the design, design trade-offs made, conceptual drawings, any schematics, and results of any modeling/prototyping/testing conducted. A summary of key characteristics, projected end-item cost range, and manufacturing considerations, shall also be included for the chosen design.

Goals/Metrics are:
General: The design shall provide a means of storing energy and providing continual replenishment of that energy as a load is applied and energy drained. The design shall also have the capability to be recharged by external means, if needed. The design shall be capable of preventing overcharge or deep-discharge, as applicable, for any rechargeable batteries used. The design shall consider safety in the event of ballistic fragmentation impact of the frame/electrical components during use in a military environment.

Power: The design shall have the ability to power an electrochromic or liquid crystal based variable transmissive protective eyewear lens (shield style) during transitions between clear (luminous transmittance as high as 90%) and sunglass states (luminous transmittance as low as 12%), and sustain that given state (as applicable). Size of the variable transmissive protective eyewear lens being powered shall be at least 6” wide x 2” high at the widest dimensions (shield style). The Phase I design shall continuously replenish power and provide sufficient capacity in such a way that it increases operating time of the variable transmissive eyewear 3-fold as compared to a non-replenishing system of equivalent capacity. Ultimate goal is uninterrupted operation of the complete device for the life of the item.

Sources of power generation: The design shall provide multiple means of power generation, such that replenishment can take place when wearing both day and night. If the lens is leveraged as a platform for power generation, the design shall maintain good optical quality of the lens (resolving power, refractive power/astigmatism, prismatic power, optical distortion), minimize haze (3% or less), and minimize effect on luminous transmittance(no visually notable difference).

Speed: The design shall be capable of supplying sufficient power to enable the lens to change from its full clear to full dark state (and vice versa) in 3 seconds or less. Ultimate goal is less than 1 second.

Weight: Target weight of initial working prototype (frame, electronics, and associated variable transmissive lens) is: 4 ounces or less (with an ultimate goal of 2.5 ounces or less) if a spectacle platform is chosen; and 7 ounces or less (with an ultimate goal of 5.5 ounces or less) if a goggle platform is chosen.

Cost: Goal is an overall large scale production product cost (frame, electronics, and associated variable transmissive lens) of $125 or less (base year 2012, prior to inflation), with an ultimate goal of $75, or less.

Cost and performance Trade-offs shall be considered during the effort to achieve overall best value.
Partnering with an eyewear manufacturer and/or provider of variable transmissive protective eyewear products (in development or production) is highly encouraged.

PHASE II: Refine design developed in Phase I (to include improvement with respect to the goals/metrics identified for Phase I) and deliver a working prototype of a functional system to the Government. The phase II prototype shall demonstrate self-powering of a variable transmission lens integrated into a ballistic fragmentation protective spectacle and/or goggle, preferably in a currently fielded military protective eyewear product. Variable transmissive technologies selected in support of this effort should be capable of meeting ANSI Z87.1 requirements. The prototype design shall be characterized, to include the goals/metrics outlined in Phase I. The system delivered to the government shall include all drive electronics and any associated cables required for initial charging of the system.

The system shall be geared toward operation in multiple environmental conditions, and deliver a report documenting: (1) the design of the device and its integration method, to include detailed drawings and schematics; (2) the fabrication processes and associated materials/equipment; (3) the experimental procedures and results that demonstrate the effectiveness of the system for its intended purpose over prolonged periods of time under various conditions (to include low light levels) (5) updated summary of key characteristics, end item cost estimates, and manufacturing considerations, to include any special processes or equipment anticipated for production purposes and degree to which goals/metrics are met (6) produce ten prototype devices to demonstrate the innovative technology in a relevant environment. In addition, prototypes will be tested on a system level to ensure integration and operational performance. The success of performance evaluation and testing results, if favorable, will lead into Phase III applications. All research, development and prototype designs shall be documented with detailed descriptions and specifications of the materials, designs, processes, and performance

PHASE III: Upon successful completion of the research and development in Phase I and Phase II, the Self Contained/Self Powering system shall be manufactured in conjunction with a corresponding Variable Transmissive protective eyewear. Prior to use in an operational environment, the complete system must, at a minimum, demonstrate compliance with ballistic fragmentation and ANSI Z87.1 requirements, and ability for prolonged use without the need to be recharged by an external source. In addition, this technology can be applied to civilian law enforcement and outdoor equipment with similar operational and recreational purposes.

REFERENCES:

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(2) Office of Naval Research Fast Tint Protective Eyewear, ONR Program Code 03I, February 2011

(3) GL-PD 10-12, Purchase Description for Military Combat Eye Protection (MCEP) System, April 2010

(4) Phase II SBIR with Eclipse Energy Systems Inc.; Topic A08-132 “Variable Optical Transmission Lens for Integrated Eyewear Protection”

(5) Phase II SBIR with Kent Optronics, Inc.; Topic A08-132 “Variable Optical Transmission Lens for Integrated Eyewear Protection”

(6) Updated Authorized Protective Eyewear List (APEL) for Military Combat Eye Protection, dated January 30, 2012

KEYWORDS: Power, variable transmission, Optical Lens, Eyewear

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A13-047 TITLE: Novel Textile for Use on Low Cost Parachutes Employing Trigger Technology to Rapidly Degrade

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a material which has a more user and environmentally friendly disposal method than materials currently in use in Low Cost Aerial Delivery Systems (LCADS).

DESCRIPTION: Low Cost Aerial Delivery Systems (LCADS) parachutes, which account for 99% of operational airdrop, are made out of a low cost polypropylene material and are considered one-time-use. With traditional airdrop before LCADS, users had to recover all of the parachutes after each airdrop, then inspect, repair, and repack them for future use. With LCADS, users do not have to spend time on the drop zone recovering the parachutes, which significantly reduces their threat exposure. In addition, they do not have to perform the laborious, manpower-intensive tasks of repairing and repacking the parachutes. The current tempo of airdrop would literally not be possible without LCADS parachutes because there is simply not enough manpower to support the quantities of supplies being airdropped. There are three types of parachutes, in the LCADS family of systems, these are:

1. The Low Cost Low Velocity parachute (LCLV) by far the most commonly used parachute. It can airdrop bundles weighing anywhere from 500-2,200 lbs, and can be employed at altitudes ranging from 1,000 ft above ground level (AGL) to 10,000 ft mean sea level (MSL). It can safely deliver even the most sensitive supplies and has a descent rate of 15-28 fps. It costs $2,650 compared to its legacy equivalent, the G-12, which costs $4,100.

2. The Low Cost High Velocity parachute (LCHV) can also airdrop bundles weight from 500-2,200 lbs, and can be employed at altitudes ranging from 2,000 ft AGL to 25,000 ft MSL. It is used for supplies that can withstand a harder impact and has a descent rate of 60-90 fps. It costs $830 compared to its legacy equivalent, the 26-ft Ringslot, which costs $950.

3. The Low Cost Low Altitude (LCLA) parachute is used in situations that require pinpoint accuracy for smaller scale resupply. It can airdrop bundles ranging from 80-200 lbs and is employed at altitudes ranging from 150-300 ft AGL. It delivers loads at a similar descent rate to the LCLV and costs about $300.

4. The Low Cost Container (LCC) is the most common container used to hold the supplies and gets attached to the parachute. It costs $190 compared to its legacy equivalent, the A-22, which costs $470.

Over 5,000 of these disposable systems are dropped in theater every month making LCADS the primary method for soldier resupply for fuel, food and ammunitions. The use of LCADS is especially critical in remote locations that are inaccessible by vehicle due to a high security threat or rugged terrain. Each system is made using up to 800 square yards of polypropylene geo textile materials that have traditionally been used as road liners in soil filtration applications. The properties of the low cost canopy fabrics used are identified in Table 1. After the supplies are recovered from the drop zone, the parachute system remains and since it is not reused, it has to be disposed of. Users dispose of these parachutes predominantly by burning them in a pit dug directly on the drop zone. With the frequency of soldier resupply at about 5,000 loads per month in Afghanistan, users have to dispose of up to 4 million square yards of fabric monthly. Not only is this task laborious and time consuming, but also the toxic byproducts of the combustion have the potential to introduce soldiers to health risks. It is widely known that large plastic fires produce a significant amount of environmentally toxic pollutants that can be considered a significant health hazard.

The ability to more quickly and easily to dispose of the parachutes in a less toxic manner will be a significant benefit to the deployed user community. This SBIR topic serves to focus on developing novel materials to achieve that goal. The most desirable technologies would allow the users to completely abandon the parachutes on the drop zone where they land, with the confidence that within days or weeks the material will have fully or partially degraded upon application of a trigger to eliminate its physical footprint. Materials that have the ability to partially or fully degrade through various trigger mechanisms (such as thermal, mechanical, photochemical, biological, chemical, or electrical) in a time period that could range from a few seconds to a few days are most desirable. Degradation can be initiated by natural means or via a man-made trigger. Materials can be films, woven fabric, nonwoven fabric, webbings, tape, or cord that are flexible, low in weight and possess moderate to high strength. Any materials developed would need to meet or exceed the current material performance identified in Table 1, as well as be shelf stable for up to 2 months at 140F. At a minimum, novel materials that meet the current polypropylene material properties in Table 1 while also being less toxic when burned would be considered with the provision that the solution adds no additional disposal requirements to the user. The current cost of the currently used material when purchased at high quantities is approximately $1.50 per linear yard. Cost is a significant factor in successful material development and the proposed materials should not exceed the current rate.

TABLE 1

MATERIAL CHARACTERISTIC	TEST METHOD	PARACHUTE TYPE & MATERIAL REQUIREM		
		LCLA	LCHV	LCLV
WEIGHT (OZ/SQ.YD.)	ASTM D 5261	2.8 MAX.	3.9 MAX.	2.7 MAX.
TENSILE STRENGTH - WARP (LB.)	ASTM D 4632	120 MIN.	150 MIN.	138 MIN.
TENSILE STRENGTH - FILLING (LB.)	ASTM D 4632	90 MIN.	130 MIN.	95 MIN.
ELONGATION, WARP (PERCENT)	ASTM D 4632	15 MIN.	15 MIN.	20 MIN
ELONGATION, FILLLING (PERCENT)	ASTM D 4632	15 MIN.	13 MIN.	15 MIN.
TEAR STRENGTH, WARP (LB.)	ASTM D 4533	50 MIN.	50 MIN.	60 MIN.
TEAR STRENGTH, FILLING (LB.)	ASTM D 4533	45 MIN.	50 MIN.	50 MIN.
AIR PERMEABILITY (CUBIC FT. PER MINUTE PER SQ. FT.)	ASTM D 737	15-55	18-45	16-40
WIDTH		60	3	88

PHASE I: This phase will focus on establishing the technical feasibility to develop novel materials that will degrade quickly upon application of a trigger or identification of a technology that will enable the LCADS to be disposed of in a more user and environmentally friendly method than currently employed. The proposed material having the ability to degrade upon application of a trigger must do so while meeting or exceeding the same specifications that are currently established for the LCADS polypropylene. Various trigger mechanisms should be explored; however, the trigger must be employable within the scope of an airdrop mission. The trigger must be able to be activated in a range of environmental conditions including, hot, cold, tropical, arid, etc. In addition, the material shall be the same cost or less expensive than the current polypropylene. Upon application of a trigger, the material should have a response rate to complete degradation in a timeframe minimum of a few seconds up to a maximum of a few weeks. Trigger mechanisms such as thermal, mechanical, photochemical, biological, chemical, or electrical can be considered.

For those technologies that would aim to make the low cost materials more environmentally friendly to dispose of by reducing the toxicity of materials when burned, the proposed material would need to have at least a 50% reduction in toxicity when compared to the currently used materials identified in Table 1. In addition to being less toxic, any proposed material shall be of similar or lesser weight and cost as compared to current materials, as well as possess similar or better performance in terms of strength, flexibility, durability, sewability, parachute packability and overall stability to storage conditions.

Bench top proof of concept demonstrations of the material performance shall be performed to establish and evaluate the material's suitability for replacement of the polypropylene. The same test procedures that are used to validate the current polypropylene shall be used to test the new material, and are identified in Table I. It is essential that any proposed solution including textiles that fall under the Berry Amendment would comply with all its requirements. The most effective material or materials will be determined and proposed for Phase II efforts. A report and functioning material samples shall be delivered documenting the research and testing development supporting the effort along with a detailed description of materials, processes and associated risk for the proposed Phase II effort.

PHASE II: During Phase II, further development of the concepts derived in Phase I could be pursued with the ultimate goal to demonstrate the material's performance on equipment prototype of a LCLV, LCLA or LCHV systems. The awardee shall develop, demonstrate, and deliver fabric and parachute prototype(s) that are in accordance with the objectives identified in Phase I as both meeting the LCADS polypropylene specifications and demonstrating rapid degradation. In addition to the delivery of fabric and equipment prototypes, a report shall be delivered documenting the research and development supporting the effort along with a detailed description and specification of the materials, designs, performance and manufacturing processes.

PHASE III: High strength, low cost, synthetic fabrics that are more environmentally friendly to dispose of and materials that are stable until acted upon to degrade by a trigger will have potential commercial applications in construction, manufacturing, medical, clothing, cleaning and food industries. The offeror should aggressively pursue opportunities for the employment of the proposed technologies in these applications or other innovative uses.

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KEYWORDS: polypropylene, parachute, toxic, combustion

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A13-048 TITLE: Non-toxic Insect-resistant Textiles for Military Clothing and Equipment

TECHNOLOGY AREAS: Materials/Processes, Human Systems

OBJECTIVE: Design and develop a novel, non-toxic, textile system for use in military clothing and equipment that will hinder arthropod-human contact and so reduce risk of exposure to insect-borne disease.

DESCRIPTION: The most common means of avoiding insect bites or stings is through application of chemical formulations (insecticidal or repellent) to skin or clothing. Further measures undertaken on a broader scale will often include spraying or otherwise treating insect breeding areas with more potent insecticidal formulations. In the military, the current standard of protection for individuals required by the Department of Defense (DoD) is the DoD Insect Repellent System which consists of 1) a permethrin treated uniform; 2) DEET applied on exposed skin; and 3) proper wear of the military uniform [1]. The factory treated permethrin uniform was first issued to soldiers in July 2010, as the Flame-Resistant Army Combat Uniform, FR ACU-P (in both the Universal Camouflage Pattern and the OCP, Operation Enduring Freedom Camouflage Pattern, aka Multicam) which is made of a permethrin impregnated textile, in addition to the FR treatment. Future plans include issuance of the factory-treated non flame resistant Army Combat Uniform (ACU), most likely in 2013 [2]. Currently the ACU is required to be individually treated by the soldier or at the unit level, using the required permethrin application kit [3].

While effective, the DoD Insect Repellent System has several critical drawbacks. First, there is often a problem of compliance. When strictly adhering to the System, the soldier can expect excellent protection. However, surveys of troops redeploying from theatres of operation, as well as the rates of vector-borne diseases from recent operations, indicate that the use of any of the required protective measures, particularly the topical repellent, is low among service members [4]. In addition, there is a growing body of evidence that points to a rapidly developing biological resistance of the insect vector to existing insecticidal chemical formulations [5-8]. There is also significant concern regarding unintended harm to benign organisms: permethrin is a broad spectrum chemical, so in addition to eliminating the intended pest, it is also highly toxic to fish and aquatic life, honeybees and other insects, as well as to some mammals [9]. There are other environmental and ecological concerns. The permethrin treatments have a limited life span, and with normal wear and usage, as well as laundering of the ACU there will be loss of permethrin content, perhaps to the home environment as well as possible contamination into the wastewater stream from wash cycles. In addition, certain individuals, such as pregnant female soldiers or people with chemical sensitivities, may wish to avoid contact with permethrin treated fabrics. Finally, eventual disposal of the uniforms may raise the question of whether or not these textiles can safely be buried in landfills without further contamination of the ecosystem.

There is a clear need to develop an alternative to permethrin treated textiles that can provide a safe, non-toxic method of protecting humans from contact with insect vectors to prevent the transmission of serious, debilitating diseases. However, the main challenge to finding such a solution is that the textile must be comfortable to wear in hot and humid climates. Any textile that is even moderately tightly woven or thick enough will prevent a mosquito from penetrating the clothing layer and reaching the skin of the target host. Fur on an animal host is highly effective at preventing insects from stinging or biting. But for the specific application of insect resistant clothing, the textile must meet thermophysiological requirements so that it will be tolerable to wear in the expected climate conditions.

In summary, the requirements will be to develop and apply processing techniques or structural design to fabrics or fibers to be used in the production of textiles for soldier clothing or other personal use (bed nets, sleeping bags, tent materials etc.) that will hinder or prevent contact of the insect vector with human skin. The novel textile system may be based on a fabric coating or treatment that will thwart insect stings or bites, or a textile structure itself that will provide a physical barrier to insect attack. The method of protection must be via a mechanical or physical interference with the mode of insect attack, or other means of deterrence, for example, optical, electrostatic, acoustic, or other, so long as there is no deleterious effect of the protective mechanism on the human user. In addition, the clothing textiles must be comfortable to wear in warm and humid weather conditions, breathable, lightweight, and launderable, and all textiles should have no negative impact on the environment in terms of life cycle use or end of use disposal issues. Finally, the textile must be able to be produced in sufficient quantities for practical application to the clothing and equipment markets.

PHASE I: Develop an initial design for an innovative textile or textile system that will prevent direct contact of the hematophagous organism (e.g. sandfly, blackfly, tsetse fly, bedbug, mosquito, tick, louse, mite, midge, or flea) with human skin. For baseline design concepts and evaluation of protective capability against insects, the mosquito will be used as the target pest.

The design criteria for insect resistant textiles may be dependent on mosquito anatomy such as proboscis length and diameter [9], or mosquito sensory capabilities. The proposed textile must have unique characteristics such that it will function as a protective barrier, while still meeting thermophysiological requirements. These characteristics may include but are not limited to high fabric thickness, surface or near-surface impenetrability, or an ultra-smooth surface that make it difficult for the insect to maintain contact.

The design criteria for insect resistant textiles will also be dependent on comfort parameters. For example, the textile must provide adequately sized pores that offer good air circulation but will hinder the insect from making direct contact with the skin [10].

To demonstrate proof of concept, produce 3-5 different textile systems and measure protective capability of the novel fabrics against live mosquitoes by using an in vitro bioassay system such as the Klun & Debboun module bioassay system [11] or an in vivo method using human volunteers which is based on ASTM 951-94 (2006), "Laboratory Testing of Non-Commercial Mosquito Repellent Formulations On the Skin" [12]. In general, in vivo bioassays are preferable to in vitro testing. Textiles must demonstrate a minimum of 70% bite protection by either method. Evaluate expected comfort parameters of the novel textiles through characterization of fabric swatches for thermal conductivity, moisture vapor transport, and tactile properties. Novel textiles produced for phase I should be in sufficient quantities to allow performance testing and comfort characterization. Phase I final report should include discussion of risk assessment regarding potential toxicity issues. The finished textiles should not present a health hazard and are expected to demonstrate compatibility with prolonged, direct skin contact when tested in Phase II. If there is sufficient historical use data, toxicity testing may not be required.

For novel textiles, physical properties including weight, tearing strength, air permeability, and wicking should not vary by more than 10% from the current U.S. Army Combat Uniform (FR ACU or ACU) or current U.S. Army Combat Shirt (ACS) standards.

Army Combat Uniform		Army Combat Shirt	
Weight, oz./sq.yd. minimum maximum	 5.5 8.5	Weight (oz./sq. yd.) minimum maximum	 5.2 6.9
Breaking strength, lbs. (minimum) Warp Filling	 100 80	Bursting strength, lbs. (minimum)	 35
Air permeability, cu.ft./min./sq.ft. (minimum)	 10.0	Air permeability, cu.ft./min./sq.ft. (minimum)	 30.0
Tearing strength, lbs. (minimum) Dry Warp Filling	 4.0 4.0	Wicking, inches/hour (length and width) minimum	 3.0

Multi-functionality in the novel textile system is acceptable, for example insect resistance and flame resistance, or insect resistance and fragmentation protection.

PHASE II: For textiles that performed well in Phase I both against live mosquitoes and for comfort testing, expand and refine the original design concept to enhance performance and comfort levels. Use human volunteer studies for evaluation of efficacy against insect bites, for example, the arm-in-cage method [13], as well as larger scale testing of textiles for comfort parameters, such as instrumented manikins. Provide a detailed plan for the scale-up of textile production so that sufficient quantities of materials can be produced using current (or other practicable manufacturing methods) by the clothing and individual equipment industry. Required Phase II deliverables will include 2-4 improved textile systems with additional materials for performance and comfort evaluation, as well as 2-4 examples of finished clothing using the improved materials. Textile properties and a detailed report of test results must be provided.

Human toxicity will also need to be considered and the safety of the materials confirmed. If there is sufficient historical use data, toxicity testing may not be required. If toxicity testing is required this will be conducted in a two phase study: 1) an acute dermal irritation study and a skin sensitization study shall be conducted on laboratory animals, and 2) when the results of these studies indicate the cloth is not a sensitizer or irritant, a Repeat Insult Patch Test shall be performed in accordance with the Modified Draize Procedure [14]. If performed, toxicity test results should be included in the detailed report.

PHASE III: Insect-resistant textiles produced for use in military clothing will have clear application to the commercial market as well. Vector borne disease is a world-wide problem of enormous scale and devastating impact, particularly in less developed countries. Protective textiles for use as bednets or clothing that use non-chemical methods are not vulnerable to issues of biological resistance, and could play a significant role in reducing prevalence of disease. For the domestic sports and athletic clothing market, insect resistant textiles may also provide a preferred alternative to chemically treated fabrics.

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[2] Program Executive Office- Soldier, Flame Resistant Army Combat Uniform- Permethrin (FR ACU-P), https://peosoldier.army.mil/faqs/fracu.asp; accessed March 21, 2012.

[3] Soldiers can still field treat their ACU's with permethrin using the standard military clothing repellent products: aerosol spray (NSN 6840-01-278-1336) or Individual dynamic Absorption (IDA) kit (NSN 6840-01-345-0237). At the unit level, ACUs are treated with permethrin via DoD-certified applicators and a two-gallon sprayer (NSN 6840-01-334-2666).

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[9] Ramasubramanian MK, Barham OM, Swaminathan V. Mechanics of a mosquito bite with applications to microneedle design. Bioinspir Biomim. 2008; 3:046001.

[10] Collins, Lynda E., "Non –Chemical Insecticidal Textiles", Master Thesis submitted to North Carolina State University, Raleigh, NC 2008.

[11] A. J. Klun et al., A new in vitro bioassay system for discovery of novel human-use mosquito repellents, J. Am. Mosq. Control Assoc., 21, 64, 2005.

[12] American Society for Testing and Materials [ASTM] Laboratory Testing of Non-Commercial Mosquito Repellent Formulations On the Skin, ASTM-E951-94(2006).

[13] U.S. Environmental Protection Agency, Office of Chemical Safety and Pollution Prevention (OCSPP), OCSPP Harmonized Test Guidelines, Series 810 - Product Performance Test Guidelines: OPPTS 810.3700: Insect Repellents to be Applied to Human Skin (July 2010), http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0150-0011.

[14] Repeat Insult Patch Test - Modified Draize Procedure; Principles and Methods of Toxicology, (fourth edition) A. Wallace Hayes (editor), pp 1057 - 1060, 2001. Copies are available online at http://www.taylorandfrancis.co.uk/ or from Taylor and Francis, 325 Chestnut Street, Philadelphia PA 19106.

KEYWORDS: fibers, fabrics, textiles, textile treatment, textile structure, insect resistant, vector-borne disease

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A13-049 TITLE: <u>Innovative Technologies for Miniaturized Affordable Battlefield Hardened Proximity Sensor</u>

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Ammunition

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: This SBIR will develop innovative, miniaturized, robust and cost effective alternative technologies for the next generation proximity sensor used in Height of Burst (HOB) munitions.

DESCRIPTION: Height of Burst (HoB) Fuzing technology (aka proximity sensor) is used in modern fuze design to increase the lethality of a weapon system against area targets (e.g. troops in the open, light skinned vehicles) by detonating its munition at a predetermined distance from the target rather than allowing the munition to impact the target before initiation. Next generation end-game proximity sensors will enable smaller, more precise weapons to be effective on the battlefield while minimizing collateral damage and maximizing effectiveness on targets. Technologies must operate in complex terrain in a battlefield increasingly rich with intentional and unintentional electromagnetic interference. The challenge is to develop and integrate these technologies and package them within a very small volume in a way that is affordable and will operate within the weapon environment.

Existing and planned technologies could be susceptible to certain electronic countermeasures and the harsh environment of gun launch. They are also relatively large in scale with respect to other ammunition electronics, taking up valuable space that could be allocated to explosives or reducing the weight of the munition.

The proposed solution must include the entire sensor from the receiver through the emitter and the processing electronics, and must consider the potential for broad application (multiple platforms) by keeping the functionality as generic as possible. Maintaining generic functionality and including protection of programmable devices reduces the likelihood of reverse engineering that can compromise HOB technology. This SBIR will compliment the maturation and development of the next generation of miniature proximity sensors by offering different and unique potential solutions.

The solution must demonstrate the required capabilities at a cost less than or comparable to existing technology for mortars and artillery, and must be capable of withstanding gun launch shock environments for munitions ranging from Artillery to medium caliber applications as well as maintaining performance across a -55°C to +85°C temperature range. The requirement is for a small form-factor (less than 1/2 cubic inch) to fit within existing weapon systems.

PHASE I: Develop an innovative conceptual solution or solutions that address the requirements of the next generation proximity sensor while minimizing cost, size, weight and power. Deliver an engineering study that identifies the key component or components that will be demonstrated in Phase II, and technical risks associated. Specific next generation proximity sensor requirements will be provided upon contract award.

PHASE II: Design and fabricate prototypes of the key component or components defined in Phase I and demonstrate that they meet performance requirements. A cost analysis will also be delivered to estimate unit production costs of the components. An engineering study will also be delivered to define how the developed technology will be integrated into current and planned future ammunition systems.

PHASE III: Assuming success, this technology could be used in existing and planned future proximity fuze applications, either as a pre-planned product improvement or insertion into development efforts. The technology will enable a new generation of precision proximity sensors to be deployed on a wide range of weapons. Commercial applications for the technology could include automotive proximity sensing, RFID, intrusion sensing and other RF sensors.

REFERENCES: The below references are available on the DTIC website.

1. Technology Trends in Fuze and Munitions Power Sources; 19 May 2010; Oliver Barham

2. Course Correction Fuzes Integration Technologies; Presented at the 55th Annual Fuze Conference; 24-26 May, 2011; Max Perrin

3. Multi-Option Fuze for Artillery (MOFA)Using Risk Mitigation Process to Develop and Implement Automation and Automation; Presented at 48th Annual NDIA Fuze Conference; 28 April 2004; Todd Anderson

4. Extended Range Guided Munition (ERGM) Safe & Arm Device and Height-of-Burst Sensor, NDIA Fuze Conference 9 April, 2003, Robert Hertlein & Mark Miner

KEYWORDS: proximity sensor, RF, radar, integrated circuit, electronic packaging, anti-tamper, affordable, small form-factor, miniature, fuze, next generation, ammunition, ammo, mortar, artillery, bomb, missile, height of burst, HOB

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A13-050 TITLE: Miniature Actuator Controls for 40mm Guided and Surveillance Projectiles

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Ammunition

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Design and develop an innovative control and surveillance system for the 40mm guided extended flight surveillance projectile with precision engagement of varying targets out to 1,000 meters, and provide real time target data back to the weapon operator.

DESCRIPTION: This innovative technology will provide increased range (up to 1000 meters) for the current low velocity 40mm projectile fired from the M320 weapon, guided for precision engagement of the target. The Squad will be able to select and/or change the target as the projectile travels, and transmit target information to Command and Control assets for situational awareness.

This topic will develop a miniature (20g and 35mm diameter or less) actuation and surveillance system(s) with algorithms in-place to control the projectile. Miniature actuators need to fit on the 40mm and survive the following conditions: 4000 psi, 22,000gs; and have low cost (as compared to existing 40mm fuzing), low power consumption, and rapid (fraction of a second) response time.

The current 40mm airframe(s) have the following specifications:
Length = 6 +/- 1/2 inches
Weight = 178 +/- 10 grams
Diameter = not to exceed 39.9 mm
Muzzle velocity = 78m/s

Previous efforts (e.g. the DARPA SCORPION program - see references) have investigated technologies at limited ranges (up to 200 meters) for specific conditions (i.e. targets in defalade) and do not include a surveillance capability. This effort will investigate technologies that will satisfy all known target conditions (i.e. exposed or in defalade, moving or stationary, etc), include surveillance and be affordable for mass production.

PHASE I: Develop a model and provide drawings, aerodynamic analysis of functioning on the improved 40mm projectile, and create a flight dynamics model. Deliver an engineering analysis that defines the proposed technologies and the technical risks associated.

Note: Technical drawings and flight characteristics of the existing 40mm projectile will be provided to the selected companies after contract award.

PHASE II: Develop a prototype control and surveillance system with algorithm incorporated and demonstrate pre-programmed maneuvers. Also deliver an engineering analysis that defines the integration concept into existing and planned future ammunition as applicable, including estimated production unit costs.

PHASE III: This effort, if successful, will feed into a planned FY16 start EMD program for extended range precision 40mm ammunition.

There is also a need in private industry for these Miniature actuator controls on all types of machinery and micro devices being developed. Commercial use includes machinery requiring small actuation systems, private micro-aircraft usage, and actuators for space vehicles/satellites.

REFERENCES:
1) W. Davis, Jr., et al., “Micro Air Vehicles for Optical Surveillance, “The Lincoln Laboratory Journal”.

2) Hamburg, Shanti, “Conceptual Design of a Stowable Ruggedized Micro Aerial Vehicle”, Masters Thesis, Aerospace Engineering, University of West Virginia, 2010.

3) Green, William E., “A Multimodal Micro Air Vehicle for Autonomous Flight in Near-Earth Environments, Drexel University, 2007.

4) Lovas, Andre, et al, "DARPA SCORPION Program Transition to Army Lethality ATO Program: A Success Story", undated

KEYWORDS: guided projectile, guidance system, microsystems, canard activation systems, 40mm, extended range, medium caliber, surviellance, precision munition,

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A13-051 TITLE: Intelligent Charge Control System w/Anti-Idle to Minimize Fuel Consumption

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Develop software to demonstrate a minimum of 10% fuel savings over a 72 hour combat mission combining power management to control battery state of charge and battery rate of charge with anti-idling technology to only run the engine when truly necessary. The strategy will be demonstrated on a military ground vehicle to validate fuel savings of at least 10% on the mission.

DESCRIPTION: Currently, the vehicles' batteries, diesel engine, and power generation are not networked and intelligently controlled on today’s military ground vehicles. The technical challenge will be the system integration approach and in writing the software to connect and control these three systems together to achieve the optimal fuel consumption without changing how the soldier operates the vehicle and without reducing mission readiness. Today fuel is not consumed in the most optimal way and much energy is lost during stationary vehicle idling. All combat vehicles are required to idle for at least 50 hours of a 72 hour mission. It is during this idle time that the greatest fuel can be saved if the batteries are intelligently charged and discharged, the diesel engine is turned off and on, and the power generation power output is controlled.

System will utilize a Niehoff 570amp alternator on a CAT C7 engine. Vehicle integration will be on a MRAP or Stryker.

The final product will be a vehicle level software control package utilizing a networked battery monitor and an alternator whose voltage is dynamically controllable to optimize power control and battery charging. This software will likely operate on a computing resource provided by the contractor for this effort and will not be required to be fully integrated into one of the vehicle's computers. In addition a test report will be provided to document the fuel savings and the performance of the intelligent battery charge control with anti-idling algorithm.

PHASE I: Identify the hardware technologies required for successful integration (batteries, battery monitoring system, control computer, etc.). Acquire CAN network interfaces for the alternator voltage regulator, battery management system, and the engine electronic control unit. Define phase II plan to develop and demonstrate/test the technology. Develop preliminary plan for vehicle integration.

PHASE II: Integrate a power management system with battery monitoring with charge control and intelligent anti-idling technology on a military ground platform capable of communicating and control via CAN. Test the power management software on a vehicle to verify at least a 10% reduction in fuel consumption is realized during a 50 hour engine idle. The electrical power draw from mission loads will average 2kW during the 50 hours of engine idling on the combat mission. The contractor will deliver the power management software, CAN interfaces, interconnect drawings, and final test report detailing results as compared to the same vehicle when the anti-idling software is disabled.

PHASE III: The idea would be for this software technology to be integrated onto an already existing vehicle computer or on a very small contractor supplied control box. The software will need to be continually tailored as it is applied and sold to the vehicle OEMs that have different alternators, engines, and/or battery monitoring systems. There will be multiple follow-on integration efforts in order to get this technology on to as many military ground vehicle platforms as possible. The technology will next be integrated on to an Abrams tank and Bradley vehicle, followed by any other platform with significant idling time during deployed operations, such as trucks waiting in a convoy.

REFERENCES:

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KEYWORDS: Power Management, anti-idling, battery management, software, CAN

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A13-052 TITLE: Modeling of Complex Environment for Unmanned Ground Vehicles Performance Evaluations

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Develop a simulation environment including different building materials and weather conditions to further evaluate existing radio, waveform and antenna models for use in Unmanned Ground Vehicles mission applications.

DESCRIPTION: Most of the current fielded Unmanned Ground Vehicle (UGV) functionality is dependent on the ability to drive the UGV using teleoperation technology. In addition a large number of payloads require teleoperation to perform their mission function. Teleoperation technology is dependent on providing the operator streaming video, which is reliant on radio capabilities along with video format, resolution and compression routines. Field testing of different radios, antennas and waveforms can be expensive and somewhat inconclusive for complex environments involving missions such as building clearing.

The ability to model channel characteristics like latency, packet/data loss and distorted signal of radio waveforms on functions such as teleoperation and displaying these characteristics realtime on an Operator Control Unit (OCU) as distorted signals, loss of vehicle and manipulator control, etc. has been done using commercial-off-the-shelf tools. However, building clearing involves a more complex data set than current tools model. There is a need to evaluate different building materials such as wood, steel and concrete; and their realtime effects on various radios and waveforms. In addition, architectural configurations of different floors, rooms, halls and interiors will also impact radio performance, and should be evaluated. Repeaters are being looked at as a potential solution for maintaining signal strength at the OCU. Being able to model these complex environments and the impacts on the signal quality of different radio and antenna options would be a valuable tool.

Weather also provides an effect on radio performance and signal strengths. Current modeling tools only address weather at a low resolution. Providing a more complex weather environment such as wind, rain, snow, fog and dust that would accurately impact the performance of the Qualnet realtime radio modeling is important.

This topic is seeking advancements in the simulation environment that can impact radio modeling being performed by Qualnet commercial-off-the-shelf tools. Building materials and weather modeling will need to send updated data and information to the radio modeling tool that can then be used to impact the latency, packet/data loss and signal strength of streaming video algorithms for performance evaluation. Assume that existing simulation environment federation tools such as Modeling Architecture for Technology Research and EXperimentation (MATREX) will be able to support some of the transfer of data between the simulation environment and radio modeling.

PHASE I: The first phase consists of investigating the best way to ingest building materials into existing databases and researching potential weather models that can be leveraged for this effort. Research into the potential advantages and disadvantageous of various methods of transferring data between the complex environment tools and realtime radio modeling shall be conducted. Feasibility of the proposed approach or potential approaches for down select should be demonstrated through simple subset simulation of the end product. A final report documenting the activities in the project will be delivered.

PHASE II: The second phase consists of a final design and full implementation of the system. At the end of the contract, complete building materials and their interiors will be modeled along with the selected weather model integrated into a seamless real time application with the commercial-off-the-shelf radio modeling tools. Deliverables shall include the complete simulation environment performing a relevant military application that sufficiently tests the building material and weather models, and a final report, which shall contain documentation of all activities in this project and a user's guide and technical specifications for the simulation system.

PHASE III: Commercial opportunities include any applications that require evaluation of radios for sending streaming video through complex urban environments. Some of the many potential applications include civilian search and rescue, and fire fighting, along with military applications in surveillance and reconnaissance. Additionally, this research has application for controlling multiple robots, or autonomous robotic teaming applications.

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1. Initial Investigation of Surface Waves on Walls Over the WLAN Spectrum, Morrow, I.L.; James, J.R.; Cushnaghan, P.; Fairweather, A.S.; Antennas and Propagation, 2003. (ICAP 2003). Twelfth International Conference on (Conf. Publ. No. 491), Volume: 1, 2003, Page(s): 76 – 79.

2. A Wireless Propagation Channel Model with Meteorological Quantities Using Neural Networks,

Moazzeni, T.; Consumer Communications and Networking Conference, 2006. CCNC 2006. 3rd IEEE, Volume: 2, 2006 , Page(s): 1307 - 1309

3. SNT, “QualNet-5.1-Wireless-ModelLibrary”, www.scalable-networks.com, 2011.

4. SNT, “Interface Design Description (IDD) for Communication Effects Server (CES) 7.0. Rev N”, December 22, 2010.

5. SNT, “QualNet-5.0.2-UrbanPropagation-ModelLibrary”, www.scalable-networks.com, 2011.

KEYWORDS: Unmanned Ground Vehicle, teleoperation, Operator Control Unit, repeaters, radio, antennas, waveforms, latency, weather

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A13-053 TITLE: High Bandwidth, Compact, Wireless, Millimeter Wave Intra-Missile Datalink

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Missiles and Space

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a prototype high bandwidth (>2 Gb/s) millimeter wave two-way data link for intra-missile communications.

DESCRIPTION: The Joint Attack Munitions Systems Program Management Office (JAMS PMO) has an interest in investigating wireless means of communicating the interface signals between a gimbaled sensor platform and the processing electronics in a missile to eliminate the torques and “sticktion” induced into the gimbaled platform by existing cables. The large number of cables running off and on the stabilized platform of multimode seekers creates "sticktion" (undesired torque) and unwanted vibrational coupling. The addition of multiple connections makes the problem particularly challenging, and some cables (e.g. power) and gas lines (for cooled seekers) cannot be replaced practically. However, by using an RF or optical means to send some of the RADAR, IR, and semi-active laser data from the sensors on the stabilized platform to the missile electronics, the cable bundle size may be reduced. Coaxial cables needed for radar outputs are especially cumbersome because of their thickness.

Transmitting data from the seeker to the guidance system requires data rates in excess of 2 gigabits per second (Gb/s). Laser communication links can achieve high data rates over short ranges, but they are impractical for such dynamic operational environments because they require precise line-of-sight alignment or links using fiber optical cables. Commercially available millimeter wave data links are beginning to provide the necessary bandwidths, and new millimeter wave technology integrated circuitry based on high mobility transistors is providing compact, inexpensive, deployable solutions.[1],[2],[3] Moreover, at certain frequencies (such as near 60 GHz) millimeter wave data links are resistant to jamming and eavesdropping because of atmospheric oxygen absorption.[4] Although millimeter wave data link technologies are rapidly maturing and are become increasingly commercially available, innovation is required to overcome the dual challenges of increasing the bandwidth (>2 Gb/s) while reducing the size, weight, power, and bit error rate in a system that will not be precisely aligned. (The transmitter will be mounted on or near a moving gimbal, while the receiver will be mounted deep within the missile body.)

The purpose of this topic is to perform a feasibility study and design (Phase I), then develop and demonstrate (Phase II) a prototype millimeter wave high bandwidth (>2 Gb/s) two way data link over distances less than 1 meter. The transmitter and receiver must be able to operate independently without alignment or scanning and must fit in the form factor of a tactical missile such as the Joint Air to Ground Missile (JAGM), a seven inch diameter missile. The transmitter should be capable of being mounted on the gimbaled sensor platform, so mass (<2 kg), volume, and power consumption of the link components must be minimized. The transmission distance to the receiver will be no more than 1 m, and ranges as short as 8-12 inches are typical. More information on the available volume will be provided in the award kick-off meeting. The functioning prototype must be delivered to JAMS PMO by the end of Phase II.

PHASE I: Design a prototype millimeter wave data link capable of high bandwidth (>2 Gb/s), two-way transmittal of data and communications over distances less than 1 meter without requiring alignment. The feasibility study must include a thorough link budget analysis that considers performance trade-offs between bandwidth, directionality, and propagation range in order to justify the proposed choice of operational frequencies, transmitter power, antenna gain, source modulation and detector bandwidth, etc. The deliverable will be a thorough design and development plan to demonstrate a working prototype by the end of Phase II.

PHASE II: Develop and demonstrate a prototype millimeter wave data link capable of high bandwidth (>2 Gb/s), two-way transmittal of data and communications over distances less than 1 m without requiring alignment. The prototype must demonstrate the ability to transmit data at the full bandwidth of the deliverable while simultaneously requiring the minimum in size, weight, and power. The prototype will be delivered to JAMS PMO by the end of Phase II.

PHASE III: Adapt the prototype to a fully functional, integrated intramissile wireless data link to all subsystems within an actual missile. Size, weight, and power should be reduced so that the transceiver(s) can smaller, lighter, and use less power than the sum of the data link systems it replaces. Such a data link will find widespread commercial use for high data rate indoor and automotive communications. Of particular interest are resilient high bandwidth indoor local area networks or quasi-permanent wireless data links in homes, businesses and urban environments in parallel with developments for wireless high definition broadcasts.

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KEYWORDS: Compact high bandwidth communication, short range communication, covert communication, millimeter wave communication, high bandwidth data link

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A13-054 TITLE: Advanced Warhead Design

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Missiles and Space

OBJECTIVE: The objective of this effort is the design of warheads to defeat contact fuses on RAM targets using compression wave overpressure. The analysis shall include details and test results of compression wave overpressure by advanced explosives and size/weight of warheads as a function of compression wave overpressure. Computational fluid dynamics (CFD) calculations will be required to predict the effects of closing velocity between munitions and target on the effectiveness of the warhead.

DESCRIPTION: The Counter Rockets, Artillery, and Mortar (C-RAM) program office is developing advanced systems to sense, warn, and engage rockets, artillery, and mortars (RAM). Gun and missile systems are currently being used to engage these threats. The warheads on these targets are made of relatively thick steel; therefore are difficult to defeat except for direct hits on the fuse. The probability of hitting the fuse with gun bullets or missile warhead fragments is very small; therefore usually not an option. U.S. Army Space and Missile Defense Command (SMDC) and U.S. Army Engineer Research and Development Center (ERDC) demonstrated the potential for compression wave overpressure initiation of typical foreign mortar contact fuses. Experiments were conducted on three fuse types: 1) point detonating fuse used on 60mm, 81mm, and 82mm mortars from Country A [1]; 2) point detonating fuse used on 60mm, 81mm, and 82mm mortars from Country B [1]; and 3) point detonating with optional delay typically used on 120mm mortars, see reference [1] for detailed description of these types of fuses. The fuses were tested at various standoff ranges from C-4 charges; see reference [2] for detailed experimental design. The fuses were inerted and instrumented to detect plunger movement that indicated go/no-go on initiation. Instrumentation included fuse tip pressure measurements on simulated fuses placed at the same standoff range and orientation to the explosion as the fuses under test. Conditions of the test: 1) one fuse orientation (nose on-axis to the explosive) was used; 2) tests were static (no inclusion of closing velocity effects on fuse tip overpressure); 3) atmospheric effects were not considered; and 4) fuses were inerted to instrument the firing system.

ERDC developed a structural response model of fuse firing pin system to calculate overpressures required for fuse initiation. This model was used in the experiment design and to calculate Iso-Response curves in Pressure-Impulse space for combinations of pressure and impulse that cause initiation of the fuse firing mechanism.

The computer code ConWep based on weapons effects algorithms described in reference [3] was used to predict pressure and impulse as a function of range for the C-4 explosives as part of the experimental design. These predictions were in agreement with the pressures and impulses measured in the tests.

Tests results showed that fuse initiation occurred at ranges of 1.5 meters from 5-lb of C-4 explosive with the two 60mm, 81mm, and 82mm mortar fuses and 0.75 meters from 10- lb of C-4 explosive with the 120mm mortar fuse.

As a follow on to the tests, Computational Fluid Dynamics (CFD) code Gemini [4] was used to predict the effect of closing velocity between a missile and its target on the pressure and impulse experienced by fuses. Calculations were performed for closing velocity of 1000 meters per second between warheads (explosive) and fuse. The predicted impulse was 3 times the impulse in the static measurements.

The results of these tests and analyses demonstrated that blast pressure initiation of RAM fuses is a promising defeat mechanism worthy of further phenomenology research.

PHASE I: The offeror shall perform studies on explosives that have maximum wave front compression ratios. The offeror shall design a warhead using the selected explosives and perform preliminary analysis on the designs. The offeror shall develop an experimental concept validation and data for development of a CFD model for fuse overpressure kill phenomenon.

PHASE II: The offeror shall develop a detailed simulation of the proposed warhead designs and missile/warhead engagement geometries. The simulation shall include CFD simulation of the effect of closing velocity on the compression wave overpressure. The offeror shall perform a detailed analysis of blast overpressures achieved in different engagement scenarios with the warhead against a variety of RAM targets. The offeror shall determine the type of explosive and amount of explosive (weight) required to defeat the fuses on these warheads. The offeror shall document warhead designs and simulation test results in a final report.

PHASE III: The offeror shall, in corporation with ERDC, develop a plan to develop and test the warhead design. The offeror shall perform preliminary warhead testing at ERDC facilities to validate simulations. These tests shall include dynamic rocket-sled experimentation that include closing rate effects for full fuse/blast field interaction. The final design will be marketed to the C-RAM program office and other related services. The resulting compression wave overpressure models can be marketed to commercial companies designing and building structures to withstand warhead blasts.

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KEYWORDS: compression wave, thermobaric explosive, computational fluid dynamics, high energy explosives

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A13-055 TITLE: Advanced Waveform Design and Signal Processing

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Missiles and Space

OBJECTIVE: The objective of this topic is to design waveforms that optimize extraction of radar target signals in noise and high clutter environments and discrimination of targets. The desire is to detect radar signals at much lower signal to noise+clutter (SNC) ratios and discriminate the targets based on state information and their structure in the range Doppler matrix. Image processing techniques should be considered to extract signals from the range Doppler matrix.

DESCRIPTION: Pulse compression in radar signal processing has been a standardized process for many years [1]. The basis of the standard pulse compression is the matched filter (MF) and the matched filter is the optimal filter to maximize the signal to noise ratio (SNR) given that the signal of interest is corrupted only by additive Gaussian white noise [2]. The matched filter is an excellent technique that is robust, reliable, and is easy to implement. Unfortunately, many times the signal of interest is no longer noise limited, but is instead clutter limited. The metric of interest is no longer the SNR, but it is now the signal to clutter ratio (SCR) and the MF is no longer the optimal technique.

The study of how to reduce the SCR is an open problem with no universal solution. Optimal solutions have been found for certain waveforms that maximize SCR while minimizing the mismatch loss (or the degradation in SNR compared to the MF). Examples of such filters for a 13-element Barker Code are given in the literature [4]. Other more sophisticated phase coded wave forms are a possibility. MTI filters and MTD filters also exist, but may not be applicable if both targets are moving at similar speeds relative to the radar (or are stationary) [2]. Recently, researchers have proposed iterative techniques to solve the maximization of SCR on a range cell to range cell basis using results from machine learning, compressive sampling and adaptive signal processing [5] – [10]. Results of the methods from [5] and [7] when applied to the same show that these new receive filters reduced the clutter such that target and communication signals can be extracted in high clutter environments.

The cost of the techniques in [5] - [10] compared to standard pulse compression techniques is not limited to a minor loss in SNR. There is also a significant cost increase in computational complexity. The matched filter can be written as a scaled inner product of the received signal and the transmitted signal. An inner product has a computational complexity of O(N) (N+1 multiplications and N-1 adds where N is the length of the phase coded waveform) which can trivially be attained by any modern computer. The algorithms from [5] – [10] have complexities that are on the order of O(L*N3) (where L is the number of range cells to be processed). We can usually assume that L >> N which implies that our computational complexity is greater than 4th order polynomial time. As N increases (this is desired in a radar system as it provides more energy on the target) our computational complexity soon overcomes the capacity of most standard computer systems.

The intent of this effort is to determine the most effective wave forms and signal processing methods. Follow on efforts will determine are the computationally efficiency of the waveforms and signal processing.

PHASE I: The offeror shall analytically design and test a group of algorithms that are optimum for SCR reduction in different environments The government will furnish a terrain clutter model to test the algorithms. The offeror shall design the signal processing hardware and software for processing these waveforms and estimate costs and run times to execute the algorithms.

PHASE II: The offeror shall develop a software design for implementation of the waveform simulation and execution on parallel computer architectures. The offeror shall develop a detailed simulation of the waveforms, signal processing, and hardware architecture. The offeror shall develop a computer hardware architecture and demonstrate execution of simulated signal returns using the proposed architecture. The offeror shall document the waveform designs, hardware architecture design, and test results in a final report.

PHASE III: The results of Phase II shall be presented to Government and industry for commercialization of the waveforms in future radar/ communication systems. The products for commercialization are the hardware architecture, waveform designs, signal processing algorithms and software parallelized to optimize processing on the hardware architecture.

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KEYWORDS: waveform design, advanced signal processing, reduction of signal to noise detection requirements

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A13-056 TITLE: Urban Computer Generated Forces (CGF) Models

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop and demonstrate a scalable approach for culturally driven dense population modeling at the entity level, for large urban areas, which can be hosted on Computer Generated Forces (CGF) applications like the Army's One Semi-Automated Forces (OneSAF).

DESCRIPTION: The Contemporary Operating Environment (COE) encountered by Soldiers has increasingly involved interactions with population groups and individual civilians in urban settings. Experience has shown that there is a lack of training environments that can present a densely populated area with accurate behavioral characteristics based on cultural differences and emotional factors at the individual entity level. What is needed is an approach for physical and behavioral model technologies that can accurately model the daily activities for a dense urban area that includes accurate representations of cultural and emotional responses to trainee interactions.

Specifically, One Semi-Automated Forces (OneSAF) does not provide comprehensive models of the daily clutter of urban life. This effort should research methods of providing a dense population in an urban area that accurately reflects typical activities based on the modeled culture in an entity based system such as OneSAF. Solutions should provide both pedestrian and vehicular urban clutter that reflects local culture. Approaches should be provided that allow for city sized population models with reduced resource utilization. Vehicular traffic is required to follow local traffic laws and customs. Modeled urban entities should interact in an appropriate manner with existing participants including both constructive and virtual participants.

Research should focus on innovative technologies for the representation of these culturally accurate daily activities considering reduced resource utilization balanced against high densities. Research should also focus on aspects of dynamic model resolution and fidelity of modeled systems relative to how these system interact with other actors (live, virtual, or other constructive) in a way that is meaningful in terms of fidelity.

PHASE I: The Phase I project shall determine the technical feasibility of representing large urban area entity models that replicated the daily activities of a culture. The analysis shall describe the feasibility assessment of the scalability approach and provide an assessment of resources relative to population densities. The analysis shall prove the feasibility of configurable cultural based models as well as discuss issues associated with the validation of models. The Phase I deliverables shall include the feasibility study, design concepts, validation approaches, monthly progress reports, and a final report. The Phase I final report shall provide an analysis of the application of this technology in the commercial market.

PHASE II: The Phase II project shall develop a prototype set of models that simulates a dense population in a cultural setting. The prototype shall provide a proof of concept on the variability of responses based on cultural models and provide assessment of the variability of cultural models based using a data driven approach. The Phase II proof of concept analysis shall provide an assessment of the feasibility based on an example interaction with a virtual or constructive role player. The Phase II deliverables include the software and data models for the proof of concept, monthly progress reports, and a final report.

PHASE III: Phase III will result in a dense simulation of culturally based daily activities in an urban area in OneSAF that provides mechanisms to adjust daily life patterns based on cultural differences. The system should be capable of handover and integration into OneSAF in order to provide direct support integration to existing systems such as CCTT, AVCATT, and DSTS. The resulting system should be capable of supporting simulation of urban environments to a level that supports first responders for local, state, and federal organizations for crisis planning.

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KEYWORDS: Computer Generated Forces (CGF), crowd modeling, cultural clutter, pattern of life

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A13-057 TITLE: Tactical Engagement Simulation System (TESS) Improved Laser Encoding and Decoding

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Research, develop and demonstrate prototype techniques to increase the laser link reliability and data transfer capabilities of Tactical Engagement Simulation System (TESS) lasers.

DESCRIPTION: The Army Multiple Integrated Laser Engagement Simulation (MILES) systems transmit a limited amount of data that is insufficient to provide "reasonably accurate" casualty assessment algorithms on par with constructive simulations. The Army Test Community requires more engagement data than can be conveyed using the MILES laser encoding standard and has supplemented MILES data with Radio Frequency (RF) messages. Army Testers desire to off-load this information from the radio network to the laser beam for line-of-sight direct fire engagements, thus freeing up bandwidth on the RF data network to support more complex engagement types, status monitoring and data collection. A more reliable laser data transfer over the laser link with increased data content and range is also needed for future live training improvements.

Modern Digital Signal Processing (DSP) techniques are capable of providing improved detectability compared to encoding used in MILES lasers. For a given laser link DSP using modern error correction techniques can provide improved engagement data reliability and range capability with laser eye-safety constraints suitable for Army training and testing. DSP techniques in laser detection should enhance the data throughput capability on the laser beam. The question to be studied is whether the use of DSP techniques in the laser encoding and decoding would provide sufficient data throughput capability to transmit all data required to initiate a direct fire engagement over the laser beam in a practical, reliable, and cost effective system, and thus obviate the use of the RF network messages for enhanced direct fire TESS.

The objectives are to improve TESS laser:

- Reliability with greatly improved engagement pairing rates.
- Fidelity supporting expanded weapon types and munitions.
- Fidelity supporting range-dependent engagement algorithms and probabilities for engagement assessment, and perhaps include use of additional significant factors.
- Direct fire pairing range with eye-safe lasers allowing modern longer range weapons to be adequately simulated.
- Time-critical engagement demands on supporting radio networks.

PHASE I: Investigate modern encoding, error-correction methods and digital signal processing techniques to improve the laser pairing reliability and enable transfer of an expanded set of engagement parameters from the attacker to the target in a broad range of likely atmospheric conditions. Develop a preliminary design concept to increase the laser link reliability and data transfer capabilities of TESS lasers. The objective is to reliably transfer 150 bits or more of information from the attacker to the target over the laser link for each firing event. Conduct trade-off analysis for system performance, weight, and cost. The deliverable is a report describing the design concept and results of the trade-off analysis.

PHASE II: Develop and demonstrate prototype techniques to increase the laser-link reliability and data transfer capabilities of TESS lasers. Demonstrate the prototype techniques in a laboratory environment. After suitable performance is achieved in the laboratory, develop and demonstrate a prototype system in a relevant field environment with the appropriate use conditions and limitations – range of transmission, atmospheric scintillation, short transient dwell times on target, and reliable insertion and transfer of variable parameters that can be extracted and used immediately. Demonstration will be at TRL 6. Propose changes to the Government owned MILES Communication Standard. The deliverable, in addition to the demonstrations, is a report describing the technology, designs, demonstration results, proposed changes to the MILES Communications Standard, and conclusions.

PHASE III: Transition technology to the Army - Tactical Engagement Simulation System (A-TESS) program of record (POR) using lasers and detectors suitable for incorporation into production ready products. Commercial use of technology is suitable for applications that require robust and reliable covert point-to-point communications links, minimal infrastructure (no wires, cables, or large antenna) and low probability of intercept. Deliverables may include reports, designs, A-TESS lasers, and/or an updated MILES Communications Standard.

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KEYWORDS: Tactical Engagement Simulation System (TESS), Multiple Integrated Laser Engagement Simulation (MILES), Digital Signal Processing (DSP), Laser Data Link, Optical Communications in Free Space

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A13-058 TITLE: Non-Lethal Munitions for Defeating Improvised Explosive Devices (IEDs)

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Missiles and Space

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The objective of this effort is to develop non-lethal munitions that can be used to remotely pre-detonate IEDs.

DESCRIPTION: Improvised Explosive Devices (IEDs) come in many forms including road side, vehicle borne, human borne, and in structures such as rooms. Of the 24 Army Science and Technology (S&T) Challenges, defeating IEDs includes the following three challenges: Force Protection – Soldier and Small Unit, Force Protection – On the Move (Ground), and Overburdened – Physical Burden. In order to meet these challenges, new methods must be developed for defeating IEDs by the individual soldier, while minimizing the collateral damage to humans. For example, methods for clearing rooms of IEDs without harming personnel in the room provided there are no IEDs present need to be developed. One such munitions is High Power Microwave (HPM) grenades. These are non-lethal grenades that generate an electromagnetic pulse that could be used to defeat the electronics used to activate IEDs or that could be used to attack blasting caps. In order to minimize the impact of added mass, training, etc. on the individual soldier, these munitions should fit into existing form factors such as hand or robot delivered munitions, 40 mm grenades, Rocket Propelled Grenades (RPGs), and Stinger, Hydra, and Javelin missiles. Since HPM may not be the only approach for defeating IEDs, additional innovative approaches are being sought. These munitions can be explosive or non-explosive driven. This topic aligns with the Fires Center's concept for Directed Energy employment.

PHASE I: The goal of Phase I is to develop non-lethal munitions for defeating IEDs by the individual soldier. Phase I should include defining the defeat mechanism that is to be used, deterimining the major components of these munitions, and conducting a proof-of-principle experiment in order to validate the technical approach.

PHASE II: The objectives of Phase II are to finalize the design of the counter IED munitions, to build and test prototypes, to verify that these munitions have an effect on a variety of IEDs through testing, and to begin to address issues associated with integrating them into currently fielded form factors such as the 40 mm Grenade, RPG, or Javelin missile. The proposing Firm should also identify any special handling or manufacturing issues that were identified during the prototyping process.

PHASE III: The primary use for these munitions would be military and law enforcement. Since IEDs know no boundaries, we have already seen them in use in the US. Therefore, these same non-lethal munitions would benefit the bomb squads of local, state, and federal law enforcement. One specific application that would be of benefit to both the military and law enforcement is room clearing of IEDs to minimize the threat to our soldiers and law enforcement agents and occupants of the building assuming there was no IED present.

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KEYWORDS: Pulsed power, Munitions, High Voltage, Electrical Breakdown, Laser, high power Microwave, Acoustic

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A13-059 TITLE: Innovative Technology for Secure Cloud Computing

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO Missiles and Space

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Design, develop and demonstrate innovative technology to detect, prevent, and mitigate security threats at all levels within the cloud computing environment ensuring access to timely, accurate, reliable information needed to execute tactical missions more effectively and efficiently.

DESCRIPTION: Cloud computing has matured to the point where it is becoming a mainstream source of technology for military and Government organizations. While there are many benefits to having data easily accessible in a cloud, it comes with many security risks. Some key issues include physical security, insider abuse, data encryption, third party relationships, network security, virtualization security, access controls, and application security.

Current cloud computing security techniques include the use of firewalls, antivirus software, and intrusion detection and prevention systems. While these techniques are necessary and increase the overall security of cloud computing, new and innovative solutions are being sought to ensure the information sent to the cloud and data within the cloud environment can be only accessed in a secure, effective, robust, and timely manner by authorized entities within a trusted system architecture. Every cloud deployment model faces the risk of forged access credentials or captured sensitive data. The focus of this topic addresses the following three issues to ensure information within a cloud computing environment is delivered in a secure, trusted manner: (1) malware and insider threats, (2) data centers located in unfriendly countries, and (3), external hackers implanting malware compromising the hypervisor, operation systems, or applications within the cloud.

The hypervisor is probably the most significant target an adversary may attempt to control; therefore, service providers are required to enable security which identifies unauthorized modifications and changes, detect zero day exploits and ensure the availability of applications and services rendered in a cloud environment. Another area of interest concerns sensitive data located or outsourced to data centers in ‘unfriendly’ countries or countries where laws on data privacy are somewhat undefined. The end result is to protect the integrity and transit of information in the cloud in the face of existing malware or an advanced persistent threat.

New innovative solutions are required to protect applications and data pushed to the cloud computing environment by authorized entities from being exploited or exfiltrated from advanced threats. These technologies should address one or part of one of the issues defined here to help ensure that adversaries present in the cloud cannot capture critical information. Solutions can address any part of cloud security, including but not limited to: the virtualized environments (including hypervisor), cloud architecture, hardware platforms and data encryption.

PHASE I: Research and develop tools, technique, and concepts for protecting information within a cloud computing environment. Provide a proof-of-concept design and prototype demonstrating the feasibility of the concept. Verify the Technology Readiness Level (TRL) at the conclusion of Phase I.

PHASE II: Based on the verified successful results of Phase I, refine and extend the proof-of-concept design into a fully functioning pre-production prototype. Verify the TRL at the conclusion of Phase II.

PHASE III: Develop the prototype into a comprehensive solution for the application of cloud computing security. This demonstrated capability will benefit and have transition potential to Department of Defense (DoD) weapons and support systems, federal, local and state organizations as well as commercial entities.

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1. Cloud Security Alliance. “Top Threats to Cloud Computing V1.0”. March 2010. http://www.cloudsecurityalliance.org/topthreats/csathreats.v1.0.pdf.

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KEYWORDS: cloud, cloud computing, cloud security, cloud computing environment, security, mission assurance, malware, insider threats, data centers, application, hypervisor, operating systems, security and privacy, vulnerability risk assessment

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A13-060 TITLE: Portable Fuel Analyzer

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Develop and demonstrate an analyzer to determine the acceptability of military fuels to be used in a field environment.

DESCRIPTION: The Army currently performs most fuel analysis functions in mobile laboratories which use time-consuming, manpower-intensive ASTM approved methods. The Army is looking to develop a portable fuel analyzer that will employ state-of-the-art technologies to rapidly determine the quality of a JP8, JP5, Jet A, TS-1, or diesel fuel sample at the point of use by correlating instrument results to applicable fuel specifications and required tests. The portable fuel analyzer will replace the functions currently performed by the existing Ground Fuel Contamination Test Kit (GFCTK) and the Aviation Fuel Contamination Test Kits (AFCTK). The portable fuel analyzer will allow a commander to determine the usability of fuel within 20 minutes versus waiting for test results that can take up to several hours using the current test procedures.

The small size and flexibility of the portable fuel analyzer will allow it to be transported and used at any location on the battlefield. The portable fuel analyzer will not require a laboratory-trained technician to operate allowing any fuel handler (MOS 92F) in charge of storing or distributing bulk fuel to be able to operate the portable fuel analyzer. This capability is critical as the battlefield becomes less defined and quality surveillance expediency becomes paramount to the success of an operation. The portable fuel analyzer shall be capable of being stored and operated in hot and basic climatic conditions ranging from -25ºF to +135ºF and have the ability to operate on a 24-DC volt source obtained from a common military battery, from a tactical vehicle, or from ground support equipment. The portable fuel analyzer will minimize waste by utilizing nondestructive test methodologies and by limiting the amount of consumables required. No hazardous materials will be required to operate the instrumentation of the portable fuel analyzer.

It is desired that the portable fuel analyzer be capable of quantifying fuel system icing inhibitor, corrosion inhibitor, static dissipater, +100 thermal stability improver, and fire resistant agents. It is also desired that the portable fuel analyzer shall be capable of identifying sabotage agents in the fuel.

The portable fuel analyzer shall be updatable by the Army as required as new fuels and additives come to use in the battlefield.

PHASE I: Develop an approach for the design of a portable fuel analyzer capable of analyzing military fuels to provide an indication of the fuels acceptability. Conduct proof of principle experiments supporting the concept and provide evidence of the feasibility of the approach.

PHASE II: Develop, build, and evaluate two identical prototype portable fuel analyzers meeting the requirements provided in the description of this SBIR topic and other requirements provided by the Army.

PHASE III: Technology developed under this SBIR could have an impact on military fuel distribution with the intended transition path being into the Army's Petroleum Test Kit or alternatively the Petroleum Quality Analysis System - Enhanced. The development of this technology may also find application in the commercial aviation industry or in commercial fuel analysis.

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1. Schmitigal, J., Mainero, J. “Evaluation of Alternative Technologies to Measure Fuel Density.” TARDEC Technical Report 21953, October 2010.

2. Schmitigal, J. “Evaluation of Portable Near Infrared Fuel Analysis Spectrometer.” TARDEC Technical Report 21143, August 2010.

3. Schmitigal, J., Tebbe, J., “JP-8 and other Military Fuels.” Program Manager Petroleum And Water Systems (PM-PAWS) All Hands Day, December 2011, Selfridge Air National Guard Base.

KEYWORDS: petroleum, J-8, diesel, testing, sensors, fuel, fuel analysis, aviation turbine fuel

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A13-061 TITLE: Develop Efficient/Leak Proof M1 Abrams Plenum Seal

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Develop innovative M1 Abrams plenum seal approaches which are efficient/leak proof to current production seals. The leak proof plenum seal (LPPS) will connect the turbine inlet foreign object debris (FOD) screen to the air cleaner plenum box (ACPB) inlet during power pack installations preventing dust and water intrusion during vehicle operation.

DESCRIPTION: LPPS is an innovative solution to seal and align M1 Abrams components ((power- pack assembly and air cleaner plenum box (ACPB)) which must be joined together through the LPPS in an inaccessible area. This alignment and sealing procedure occurs each time the power-pack is installed in vehicle hull. The latest production seal design (baseline metrics) requires one end of seal be clamped to front of turbine engine's FOD screen. The power package with production seal attached is then jockeyed and lowered into position until the other seal end presses against front of ACPB and power pack is locked in place. It is intended that to make sure the seal is seated and pressed against front edge of ACPB with no air gaps that a physical inspection be made through a small access cover in vehicle hull (baseline metrics). A physical inspection is not an easy task and may require power package removal and re-installation to assure proper seal alignment and re-positioning of seal to ACPB. The present production seal (one clamp design) and an earlier production seal (two clamp design) is not considered leak proof and water/dust can and have penetrated into engine compressor section causing engine damage and short engine life. Plenum seal installations in the field/camp posts are more tortuous and hazardous to perform than compared to control setting such as Army Depot's/test sites creating increased risks and barriers which continues to lead to degraded turbine life and a need for design upgraded/refinement to production seals or a new innovative LPPS design. To assure that a new design plenum seal is properly installed metrics based on performance attributes shall include: (1) alternative new seal configurations (such as tongue and groove and inflatable tube designs to leak proof mating components) which prevent seal leak paths between the ACPB to turbine inlet FOD screen, (2) this includes verification that seal design will not allow water intrusion into the engine during vehicle deep water fording tests, and (3) a new seal configuration and installation method that does not require underneath vehicle physical inspection to verify proper seal alignment.

This research effort might incorporate, (1) new materials with a new technique which is more fool proof for engaging the mating components into M1 hull during power pack installation and (2) alternatives as to which mating component the seal is attached to first prior to M1 Abrams power pack installation.

The specific technical challenges faced in the development of the LPPS are (1), understanding how the two current production seals maintain contact integrity between the air cleaner plenum box and turbine FOD screen during power pack installation and (2) current recommendation to physically crawl underneath vehicle and inspect through access cover for verification of seal alignment with no air gap between mating parts. The LPPS will provide a longer turbine engine life and more efficient fuel utilization by maintaining compressor blades integrity over longer sustained periods. Not knowing if the current production plenum bell mouth seal is properly installed creates a technical challenge and higher risk for engine compressor blade dust erosion and/or water intrusion into compressor section to occur. Knowledge of current seal design and limitations may aid in upgraded/refinements to current design or provide design savvy for developing new LPPS. Any new design alternative rubber type material must be required to meet or exceed current turbine engine bell mouth plenum seal's specification requirements.

PHASE I: Leak Proof Plenum Seal (LPPS) concepts will be explored, designed and developed based on the quantitative metrics sited in performance attributes defined in Description. The LPPS design concepts can be an upgraded/refinement of the two current production seals or a new seal design which develops a tongue and groove approach (or equivalent) compared to present design of seal pressing against outer metal lip of air cleaner housing. Included will be a trade off analysis of how LPPS will achieve leak proof conformance without intended need for seal verification by inspection through M1 Abrams hull following power pack installation. The trade-off analysis will also factor in and include the environments/operating conditions which the field/camp post installs the plenum seal in comparison to environments/operating conditions at Army Depot's/test sites. Consultations with engine, vehicle developer, user organizations, M1 Abrams and M1 Abrams overhaul facilities (Anniston/Lima) may be useful in establishing design parameters for trade-off analysis predictions. The goal of Phase I is to determine the scientific and technical merit and feasibility of a new innovative LPPS or upgraded/refinement of current seals. The LPPS development will lead to a commercialization potential demonstrating a vast improvement in M1 Abrams engine life and reduced operational and overhaul cost across the M1 Abrams vehicle fleet. Breadboard designs and/or reduced scale LPPS concepts and/or upgraded/refinements of existing seals will be proposed and demonstrated. Computational fluid dynamics (CFD) and finite element analysis (FEA) techniques will be established (if needed) to support modeling and simulation efforts.

PHASE II: Early in Phase II, the LPPS breadboard concepts studied and analyzed through trade-off evaluation in Phase I will be finalized (if needed) and the best one or two concept approach with government approval will be down selected. Prior to down selection, the quantitative metrics regarding the performance attributes will be verified and/or modified where applicable. Prototype hardware based on Phase I efforts will be built and the operation of the prototype will be demonstrated and verified. The demonstration will include operating conditions which may differ from field/camp post scenario to those operating conditions at Army Depot's and test sites. Design modifications to prototype original design will be incorporated and re-test will be conducted based on previous lab results and modeling up dates from the CFD and FEA work efforts, if used in Phase I. Continued lab tests including turbine engine power pack installations typically seen in field/camp posts and Army Depot's/test sites will be verified to realize a hardening of the design approach which will demonstrate no dust or water intrusion through the LPPS or design upgrade/refinements to existing production seals. Consultations and sub-contractor efforts with engine, vehicle developer, user organizations, and overhaul facilities may assist in establishing power pack installation trials and LPPS verification or refinement designs of current seal success. The LPPS design will be a well-defined plenum seal which meets all of Description Section, metrics, research goals and technical challenges outlined or restructured as deem necessary. The LPPS will be made commercially viable and provide a dual-use through possible new material development which may keep dust and water from penetrating in other critical areas of vehicle systems or in other critical enclosures requiring leak proof sealing.

PHASE III: The primary or end-state vision of the LPPS is the current M1 Abrams turbine engine which requires a leak proof connection during power pack installation between the engine's foreign object debris (FOD) screen and face of air cleaner plenum box permanently mounted in vehicle hull. The U.S. Army, U.S. Marines and some foreign countries which operate in dusty environments could use a new designed LPPS which is efficient/leak proof and provides a Cost Benefit Analysis (CBA) case to show increase engine life and reduced operational costs. It is envisioned that if Phase II effort is successful that M1 Abrams will fund a Phase II Enhancement to build LPPS prototypes to verify their success in field tests. This will also include support work on design, logistics and Technical Manual upgrades. LPPS application in commercial market would be most likely in developing new rubber type materials which retain sealing capability in temperature variations from – 60 F to +350 F.

REFERENCES:

(1) SAE International, Aerospace Material Specification (AMS7258) titled: Rings, Sealing Butadiene-Acrylonitrile (NBR) Rubber Fuel Resistant, Low Shrinkage, 65-75, Approved for Public Release, Reaffirmed April 2001.

(2) SAE Aerospace Material Specification (AMS3383), titled: Polytetrafluoroethylene (PTFE)-Fluorosilicone (FVMQ) Rubber High Temperature Fuel and Oil Resistance, 75-85, document declared "Stabilized" Sept 2011, Available from SAE International.

(3) Ordnance Drawing 19207-122287063, Seal Assy, Engine Plenum (newer design).

(4) Ordnance Drawing 19207-12388137, Seal Assy, Engine Plenum--Material Spec.

(5) Ordnance Drawing 19207-12273764, Seal Assembly (old design)--Material Spec.

(6) Ordnance Drawing 19207-12273122-3 Band Clamp.

(7) Portions of Technical Manual showing procedure for installing and removing power package from M1 Abrams Hull and procedure for connecting to air cleaner housing.

KEYWORDS: M1Abrams, turbine blade erosion, dust leaks, air cleaner housing, compressor blades, M1 Power Package, M1 Power Package installation, turbine foreign object debris (FOD) screen.

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A13-062 TITLE: Stand Alone Sensor for Air Bag and Restraint System Activation in An Underbody Blast Event

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a self contained sensor that activates passive safety systems such as air bags and pyrotechnic restraint systems in underbody blast events.

DESCRIPTION: The Army does not possess a sensor system which can effectively activate passive safety systems (such as air bags and pyrotechnic restraints) to provide protection to the Soldier during underbody blast events. Integration of sensors commonly found in automotive applications would not be suitable for Military vehicles, due to the fact that peak accelerations occurring in underbody blast events are larger in magnitude and occur within a shorter time span than in an automotive crash or impact event. Typical automotive crash events have peak accelerations of 25 to 50 g in a time duration of 70 to 120 milliseconds (ms) as compared to underbody blast events that have peak accelerations of 100 to 400 g in a time duration of 3 to 30 ms (REF: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA550921). During the short time duration of a blast event, the Soldier experiences high accelerative loads in which injuries and deaths occur. This effort would focus on designing, manufacturing and validating a sensor system that is self-contained, powered by an internal source and connected to the vehicle to provide diagnostic support and internal source charging. The sensor would be mounted at each seat location and would activate the necessary passive safety devices such as air bags and pyrotechnic restraint systems for that seat system in the time span of 0.5 ms from the initiation of the event to the deployment of the passive safety device. For reference purposes, in an automotive crash event, the passive safety device is activated 10 ms or later depending on the event. As developed the system cost for a self contained sensor should utilize as much off the shelf technologies as feasible to produce a system that can be reasonably produced and priced within the range of $600 per unit. As the development progresses and volumes increase unit costs should become more cost effective and approach a price point of $350 per unit.

PHASE I: Develop and design a sensor to detect underbody blast events. During this phase the sensor shall be validated through underbody blast modeling and simulation scenarios.

PHASE II: Develop, manufacture and demonstrate a prototype sensor system and validate the performance in an underbody blast. The sensor will demonstrate the ability to activate passive systems in a time span of 0.5 Milliseconds while being mounted in the intended orientation within the vehicle. Conduct testing to prove feasibility over extended operating conditions.

PHASE III: The development of this advanced sensor has potential in Military and Automotive environments in passive safety system activation in Blast, Crash and Rollover Occupant protection. When designed the self contained sensor will not require an external sensor (Satellite Sensors) to be connected to it. By eliminating the satellite sensors a cost savings of potentially $110 each (up to six sensors can be utilized at one time) exists. As a benefit to not only the Military but the Consumer Automotive exists when vehicular volumes are considered. Ideally the development will yield systems that can be directly coupled to Pyrotechnic Restraint Systems, Air Bags and other Safety Equipment which is activated via a crash sensor. This would provide further cost savings and benefits.

REFERENCES:
1. http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA550921

2. https://blastinjuryresearch.amedd.army.mil/docs/ubb/Initial_Characterization_of_Occupant_Exposure.pdf

KEYWORDS: Underbody Blast Sensor, Air Bag Sensor, Restraint Sensor, Under Body Protection, Underbody Protection, Underbody Blast Sensor, Crash Sensor, Safety Systems, Occupant Protection

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A13-063 TITLE: Dual-Function 3D Fiber-Reinforced Transparent Material for Ballistic Protection and Shock Attenuation

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Ground Combat Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Feasibility studies to investigate and develop advanced novel transparent composite materials based on advanced fibers to be manufactured into thin lightweight transparent armor to meet payload, protection, and performance requirements for current and next-generation tactical platforms.

DESCRIPTION: Current transparent armor panels are extremely heavy and thick, and pose integration challenges, as well as performance and payload penalties on tactical vehicles. These problems have often resulted in the minimization of transparent armor windows, which reduces situational awareness and may increase the platform’s vulnerability. This solicitation's focus and objectives are to address those challenges by exploiting innovative materials, designs, and/or manufacturing processes to create a lighter transparent armor different from the current technology in order to meet the protection level requirements.

Synthetic materials that take advantage of manufacturing techniques to develop fiber-based materials with three dimensional axial control including weaving techniques are of interest for this project. Recent advances in this area have resulted in development of materials with superior properties in strength, stiffness, toughness, and ballistic shock mitigation properties. With improvement of nanotechnology, discovery and exploitation of various nanostructures (such as, but not limited to, nanofibers, clay nanoplatelets, nanotubes, nanowires, etc.) and advances in composites fabrication processes it is possible to develop new structures and materials that can be integrated into a transparent armor system which can lead to tougher, lighter, and thinner transparent ballistic panels. A lighter transparent armor is needed to improve mobility, maneuverability, and survivability of crew personnel. The goal of this solicitation is to develop a new material that can offer enhanced ballistic protection with at least 30% reduction in weight and significant reduction in thickness to emphasize the importance of both light-weight and thinness at comparable cost in comparison to currently fielded transparent armor windows. Transparency requirements include at least 85% transmission of the maximum solar emission at 550 nm. Refraction coefficient and coefficient of thermal expansion of the materials should be similar to that of glass which is 1.45 in the 400-800 nm wavelength range. Stability of the index of refraction should be investigated in the range of -20 C to +40 C. The transparent armor panels must maintain the improved ballistic performance at low temperatures (-40F) and withstand thermal cycling ballistic testing profile (-60 to 180F) avoiding delamination.

PHASE I: Phase I will consist of feasibility studies of an innovative design concept for transparent armor panel by utilizing advanced materials and/or innovative fabrication techniques. The constructor must demonstrate a proof of principal 12in x 12in prototype transparent armor panel based on the proposed technology. The panels will be tested for the transparency requirements stated above and will be subjected to high and low temperature cycling as mentioned above to ensure environmental robustness. This proof of principal shall show an improvement of at least 15% compared to the current basline of ~50 psf for a standard transparent armor laminate. The thickness may be up to 4.5". The transparent ballistic panels shall defeat, at a minimum, multi-hit .30 caliber 7.62 mm Armor Piercing bullet threat at muzzle velocity. The multi-hit pattern to be utilized is available in the Army-Tank Purchase Description (ATPD) 2352.

PHASE II: Based on proof of concept the selected materials, design configuration, and manufacturing process approach shall be optimized to ensure the highest performing material for the lowest possible cost. Fabricate twelve (12) 400mm x400mm coupons for ballistic tests conducted by TARDEC. The contractor must verify the repeatability and the ballistic performances of the samples they are sending to TARDEC for ballistic testing prior to submitting the coupons to TARDEC. These results shall be provided to TARDEC. The contractor must also build a sufficient number of coupons and conduct environmental testing as described in ATPD 2352. The transparent panels provided to TARDEC shall defeat the threat identified in the description section. These panels shall show an improvement of at least 30% compared to the current baseline of ~50 psf for a standard transparent armor laminate. The thickness may be up to 4.5". The transparent ballistic panels shall defeat, at a minimum, multi-hit .50 caliber Armor Piercing bullet threat at muzzle velocity. The multi-hit pattern to be utilized is available in the Army-Tank Purchase Description (ATPD) 2352. Additionally, the contractor shall provide a cost and manufacturability assessment for the material developed via this effort.

PHASE III: The development of a novel lightweight transparent armor materials will directly impact military vehicle ballistic resistance capabilities, which can also be adapted to address civilian defense and automotive safety issues. Additionally, such technology will have a broad range of commercial applications in the airline industry. The new transparent armor materials will benefit light weight tactical vehicles enhancing agility, survivability, mobility, and payload capabilities.

The developed concept will be tested on light- to medium-weight army tactical vehicles with the potential for the translational implementations. The commercial market for the developed composite includes aircrafts, helicopters, auto industry, law enforcement, security vehicles, and security construction (bank windows, check points, etc.).

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2. Klement, R.; Rolc, S.; Mikulikova, J. K., Transparent Armor Materials, J. Eur. Chem. Soc. 2008, 28, 1091-1095.

3. Ortiz, C.; Boyce, M.C. Bioinspired Structural Materials. Science 2008, 319, 1053.

4. MIL-PRF 46108C, Performance Specification: Armor Transparent.

5. MIL-STD-662, V50 Ballistic Test for Armor.

6. Rai, K.N.; Singh, D. Impact Resistance Behavior of Polymer Nanocomposite Transparent Panels. Journal of Composite Materials 2009, 43, 139-151.

7. Yang, M.; Cao, K.; Sui, L.; Qi, Y.; Zhu, J.; Waas, A.; Arruda, E. M.; Kieffer, J.; Thouless, M. D.; Kotov, N. A., Dispersions of Aramid Nanofibers: A New Nanoscale Building Block. ACS Nano 2011, 51.

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KEYWORDS: Transparent armor; ballistic protection; lightweight; composite; armor;

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A13-064 TITLE: Hands Free Automatic Coupling Restraint System

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: PEO Ground Combat Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop and demonstrate a restraint system that automatically couples the Soldier to the ground vehicle seating system, thus eliminating the need for the Soldier to manually connect (to), activate, disconnect (from) and de-activate the restraint system.

DESCRIPTION: The current Army fleet of vehicles contains restraint systems that require the Soldier to manually put them on. If a Soldier decides not to wear his or her restraint, the consequences can result in injury or death. The proposed Hands Free Automatic Coupling Restraint System would provide Soldiers a novel restraint system that does not require them to latch or unlatch the restraint. The system would function such that when the Soldier sits in a seat he/she is automatically connected to the seat with no further input required from the Soldier. The Soldier would stay 100% connected to the seat until dismount or during an emergency evacuation, at which time the system would automatically disconnect. The challenge of this technology objective is to safeguard occupants ranging from a 5th percentile female with and without personal protective equipment to a 95th percentile male with and without personal protective equipment, while mitigating the energy generated by underbody mine blasts, Improvised Explosive Devices (IEDs), vehicle collisions (frontal, side, rear and rollover), and severe driving conditions (evasive driving and high-speed off-road driving) that is transferred to the Soldier by coupling them to the seats and allowing the seating system to absorb the energy. The restraint system combined with the seat system technology will improve occupant comfort and cross functionality of both the restraint and seating system application and utility for combat and non-combat vehicles.

PHASE I: Phase I of this effort will consist of a feasibility study for an innovative hands free automatic coupling restraint system that does not require the use of hands to operate. By utilizing modeling and simulation the innovator must successfully demonstrate the hands free coupling-decoupling capabilities in addition to demonstrating the systems safety performance compliance to Federal Motor Vehicle Safety Standard (FMVSS) 209 and 210.

PHASE II: Phase II of this effort will focus on manufacturing and validating prototypes based on Phase I work that demonstrates and validates the auto coupling Soldier restraint system described in the objective. The system shall be validated against Federal Motor Vehicle Safety Standard (FMVSS) standards (209 and 210) before a blast or crash event is conducted. The system performance shall be demonstrated via a sled test series (frontal, side, rear and roll over) and drop tower testing. The sled test environment demonstrates the capabilities of the system and the drop tower simulates the effects of underbody blast onto a seat coupled occupant in a generic environment. Parameters simulating the test modes (Accelerations, Displacements and Velocities) shall be provided to the Contractor for use in testing. To validate the performance of the restraint system the Contractor shall utilize anthropomorphic test devices that include the 5th percentile female with and without personal protective equipment and a 95th percentile male with and without personal protective equipment. Any required changes and retests shall be conducted at this time.

PHASE III: In the final Phase of the project the contractor shall prove out the effectiveness of the system on an Army Vehicle (or vehicle that is representative of a vehicle in the Army fleet) in both blast and crash scenarios as outlined in applicable sections of the Federal Motor Vehicle Safety Standard (FMVSS). This system has the potential to be utilized in both Military and Civilian truck and automotive applications. This system can replace existing safety technologies with one that is more cost effective and provides better protection to the Soldiers and Civilian.

REFERENCES:
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2. http://www.dtic.mil/dtic/tr/fulltext/u2/a546849.pdf

3. http://www.dtic.mil/dtic/tr/fulltext/u2/a029375.pdf

KEYWORDS: Restraint System, Seat Belt System, Restraints, Seat Belts, Passive Safety System,

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A13-065 TITLE: Encapsulated Air Energy Absorbing Flooring

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The majority of blast event casualties experience injuries to the lower leg. The current flooring systems are not designed to minimize occupant injuries. Little investment has been made in mitigating the blast impulse from the vehicle’s underbody structure to the occupant through the use of energy absorbing flooring systems. Underbody kits have been integrated into the survivability solution but most have a negative weight and mobility impact on the vehicle. Add-on blast mats are the only integrated and fielded solution in energy absorbing flooring solutions. There are opportunities to evaluate many other technologies to mitigate energy to reduce injury and improve weight/mobility characteristics. The objective is to develop an encapsulated air energy mitigating flooring system to mitigate energy from mine blast to reduce occupant injury. This effort addresses high priority Army demonstration programs and Army vehicle acquisition programs.

DESCRIPTION: Technology objective is to safeguard vehicle occupants and mitigate various levels of energy generated by underbody mine blast. The developed flooring system should mitigate energy so the force and acceleration seen by the occupant is below the published injury criteria for tibia, foot/ankle, and femur. Encapsulated air in a flooring system shall be utilized to mitigate energy.

Currently, there is little information on the performance of encapsulated air as it relates to occupant protection and survivability from underbelly blast threats. Understanding the potential performance characteristics of an energy mitigating flooring system that uses encapsulated air could lead to lighter vehicles, enhanced mobility, improved occupant protection, reductions in logistics/sustainment costs, and rapid manufacturing.

The areas of concern that the encapsulated air energy mitigating flooring system should address are the following objectives:
1. Provide the ability to create simplified floor systems allowing geometric blast mitigation capabilities that cannot be achieved with metallic structures.

2. Provide variable material / system properties that can be tailored to address areas of high concern or areas of low concern.
3. Realize weight reduction when compared to a comparable metallic solution.
4. Address the concern with excessive dynamic deflection of flooring systems when subjected to blast loads.
5. Provide integration flexibility that will potentially reduce logistics/sustainment costs.
6. Enhance manufacturing efficiency with low cost tooling and accelerated part production.
7. Allow efficient use of system space claim available to absorb the underbody blast impulse.

PHASE I: Develop an initial encapsulated air flooring system concept to show performance of the design in respect to reduction of occupant injury, energy transferred to the occupant, and dynamic deflection of the flooring system. The system shall reduce measured tibia compressive force below the tibia force measured on a bare floor during the same floor acceleration from a simulated blast event. The tibia axial force shall not exceed 9074N @ 0ms, 7562 @ 10ms; foot/ankle 5355N, and femur axial force 9070 @ 0ms, 7560 @ 10ms. The system shall be attached in a manner which secures the system to a generic vehicle structure and maintains integrity when subjected to an impulse of 350G peak for a period of 5ms. The concept shall show a weight savings compared to current state of the art metallic or composite energy mitigating flooring system solutions. Utilize blast (high strain rate) Modeling and Simulation (M&S) to model key elements of an encapsulated air energy mitigating flooring system concept for tactical and combat vehicles. The M&S shall show the encapsulated air flooring system concept can react to the energy from the blast within the quick blast timeline. The M&S should also show the interaction of the flooring system and the occupant seated in a vehicle with their feet on the flooring system. Provide background rationale leading to the final concept down selection (such as research completed, design iteration process, etc). For down selection of concepts use the following guidelines: performance – 60%, weight – 30%, cost – 10%. Finite Element Analysis should be conducted on the encapsulated air flooring system to ensure its ability to withstand normal military vehicle structural loads and user wear and tear with no degradation of physical properties. Conduct proof of principle experiments supporting the concept and provide evidence of the integration feasibility and manufacturability of the approach. The proof of principle experiments should support information gathered during modeling and simulation. Outputs from this phase are the CAD system model, the M&S analysis and final report which contains a summary of the Phase I effort (to include performance evaluation against the injury criteria) and includes rationale to move to Phase II.

PHASE II: Based on modeling completed in Phase I, develop, build, and validate through component level evaluation two prototype encapsulated air energy mitigating flooring systems meeting the requirements provided in the description of this SBIR and other requirements provided by the Army. Validation can be accomplished through component live fire evaluation or impulse loading evaluation to the parameters listed under Phase I. The published injury criteria for Revised Tibia Index (RTI) should be used as the metric. RTI, or the Revised Tibia Index, is an injury calculation that takes into account both the compression (Fz) and bending moments (Mx and My) of the tibia. ARL calculates RTI in both the upper and lower tibia. RTI is calculated as: RTI = (Fz/Fc) + (My/Mc), where Fz is the measured axial force, Fc is the critical compression value, My is the measured bending moment, and Mc is the critical bending value. The revised index states that appropriate critical values for the 50th percentile male are 12 kN for compression and 240 Nm for bending. Results over the 0.75 threshold correlate to an AIS2+ fracture. Outputs from this phase are the component level evaluation report, summary of the Phase II effort, and rationale to move to Phase III.

PHASE III: The proposed system created from this investment can be applied to commercial automotive, truck, marine and air craft. In addition the proposed system can be applied in Tactical Wheeled Vehicles, Tracked Vehicles, Amphibious Vehicles, Air Craft or any other type of vehicle (Construction Equipment, ATV, Fork Lifts, etc.). As applicable in Ground Systems Survivability the investment in any and all Safety Systems results in a reduction of Soldiers wounded and killed in action.

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KEYWORDS: Energy Absorption, Structures, Hull, Flooring, Safety Performance, Occupant Protection, Encapsulated Air, Blast, Injury

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A13-066 TITLE: Supplemental External Expendable Radiator (SEER)

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop a rugged, lightweight, cost effective, Supplemental External Expendable Radiator (SEER), applicable to engine cooling and resistant to the effects of military environment, which ultimately improves vehicle performance.

DESCRIPTION: Thermal issues are one of the key challenges for the current and future ground vehicle fleet. Lack of sufficient cooling limit vehicle climbing and maximum speed capability. Engine compartment space under the armor of military vehicles is extremely limited. Therefore the space given to radiators (and cooling system as a whole) is typically insufficient for full engine power realization. In addition many ground vehicles have been upgraded numbers times increasing heat load to the cooling system; typical heat rejection requirements (on some of the larger combat vehicles) are 400kW and these heat loads are projected to increase significantly in future vehicles. Thermoelectric generators illustrate an example of new technology that will add to vehicle thermal challenges (approximately 50kW).

This effort will explore the potential benefits of integrating additional on-board cooling. The first phase of this program will determine the scientific and technical merit of “integrating additional cooling”. The second phase is expected to produce a well defined deliverable prototype for testing and evaluation. The third and final phase is expected to transition technology onto a platform and/or the commercial sector.

This heat exchanger system should be “supplemental” (meaning in addition) to the current cooling system of a vehicle. Two potential research areas into what “supplemental” actually means are 1) using the SEER part time (only when needed) or 2) using the SEER continuously (attempting to lessen the power to the cooling fan). This heat exchanger system should be designed as an “external” unit (meaning outside of the armor package of the vehicle). In order to protect valuable equipment on military vehicles from battle, those sub-systems are typically integrated inside the armor of vehicles. In most cases, this design philosophy adversely impacts cooling capability due to size and air flow constraints. This heat exchanger system should be designed as an “expendable” unit (meaning if it is damaged in battle, it will not prevent mission completion). Because military vehicles are designed to operate in a battlefield environment, this requirement expects that this new heat exchanger system may become critically damaged during battle. This heat exchanger system should have some safety provisions to protect nearby soldiers on foot (outside of the vehicle), and prevent the possibility of losing all of the vehicles coolant. Such a heat exchanger would eject a certain amount of hot coolant fluid away from the vehicle and when it gets damaged. This requirement addresses the safety concerns as well as how to isolate the system (to prevent total failure). This heat exchanger system should consider heat emission reduction strategies in order to mitigate additional unwanted heat signatures detectable by an enemy. This heat exchanger system should improve the cooling capacity of an existing vehicle radiator system by at least 20% in hot ambient conditions. The overarching purpose of this technology will be to help reliably deliver troops and consumables in and to military environments (e.g. Forward Operating Bases and other expeditionary bases) with reduced risk to equipment and vehicles.

PHASE I: This effort shall fully develop multiple (at least two) concepts of a Supplemental External Expendable Radiator (SEER) for military vehicle engine cooling systems. All SEER concepts shall be compact, lightweight, efficient, cost effective, adaptable and linked to a main vehicle cooling system. This effort shall include a feasibility study of all concepts that determines the technical and commercial merit of the SEER by performing modeling and simulation of each concept, and by completing a detailed analysis and predicted performance. Each concept must provide some measureable cooling system improvement (for example, at least 1.5x improvement in cooling capacity over the baseline system).

PHASE II: A concept from Phase I will be down-selected and two Supplemental External Expendable Radiator (SEER) prototypes will be developed. The first prototype will first be fabricated using the Phase I concept design. The second prototype will be improved through a testing and redesign "Lessons Learned" process.

The first SEER prototype shall be fabricated based on the selected Phase I concept design. This prototype shall be tested and “Lessons Learned” shall be documented. Then this prototype shall be redesigned and a 2nd generation SEER prototype shall be fabricated based on those “Lessons Learned”. Lastly the 2nd generation SEER prototype shall undergo performance testing and comparison to the predicted performance goals of Phase I.

PHASE III: The "vision" or "end-state" of this research is a hot environment add-on kit that assists in vehicular performance. Since engine compartment space is extremely limited in all military ground vehicles, it can be stated that this technology can apply to all military ground vehicles. This technology could apply very readily to armored combat ground vehicles where space is even a more of a scarce resource then in non-armored tactical ground vehicles. Specifically this technology could easily transition to the Bradley vehicle, HERCULES vehicle, Stryker vehicle, and Paladin vehicle. On the tactical side, this technology could apply to all of the MRAP vehicles, JLTV concepts and up-armored HMMWV's.

There may also be applications for this technology in the automotive after market as an add-on kit for high altitude driving, or desert conditions driving, or even for the car rental industry as an add-on so that renter to do not destroy the vehicles through misuse. There may also be applications for this technology in the agricultural market also as an add-on kit for heavy work in extreme conditions vehicles.

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KEYWORDS: supplemental, external, expendable, radiator, performance improvement, temperature reduction, power increase

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A13-067 TITLE: Fuel Efficient Military Tire

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Develop a military tire for use on FMTV (Family of Medium Tactical Vehicles) with 30% lower rolling resistance than that of existing military tires while retaining 90% of the performance of existing military tires for paved road wet traction and off-road chip/chunk/tear resistance. The objective is to use for both CONUS and OCONUS.

DESCRIPTION: The Army needs improved capability to enable sustainment independence/"self-sufficiency" and to reduce sustainment demands at expeditionary basing levels. The objective is to reduce the need for fuel resupply. One avenue to reduce fuel consumption is through development of a fuel efficient military tire. This project investigates technologies which would provide a fuel efficient (lower rolling resistance) military tire for reduced sustainment demands.

PHASE I: Identify key components of the tire which contribute to fuel consumption and develop methods to reduce rolling resistance while maintaining key performance parameters. Develop a computer model of this fuel efficient tire detailing the differences in components and material characteristics. Fuel Efficiency will be measured based on Tire rolling Resistance values from model. Using modeling and simulation, subject tire to several loading scenarios to demonstrate improved performance in fuel consumption versus a conventional tire. The baseline tire is what currently used on the FMTV. Deliverables shall include methodology report, computer model and rolling resistance fuel efficiency results of modeling and simulation. Evaluation protocol will be based on simulated results of SAE J1269 Rolling Resistance Measurement Procedure for Passenger Car, Light Truck, and Highway Truck and Bus Tires in a laboratory environment at a matrix of temperature, pressures and load conditions.

PHASE II: Using the model and simulation developed in phase 1, a prototype fuel efficient military tire would be developed and tested in a lab environment. Testing would include SAE J1269 Rolling Resistance Measurement Procedure for Passenger Car, Light Truck, and Highway Truck and Bus Tires in a laboratory environment at a matrix of temperature, pressures and load conditions. In addition, testing of fuel efficient tire would be conducted for FMVSS Regulation 49CFR Part 571.119-New Pneumatic Tires for Motor Vehicles with a GVWR of more than 4,536 kilograms (10,000 pounds). Other organizations may be interested in transitioning of this technology based on successful results Deliverables shall include 40 prototype tires in 395/85R20 size in military on/off road tread pattron, and report of laboratory testing.

PHASE III: Prototype fuel efficient tires would be evaluated on a FMTV military vehicle for fuel consumption in accordance with SAE J1321 JOINT TMC/SAE FUEL CONSUMPTION TEST PROCEDURE - TYPE II, performance characteristics (braking and handling) and durability operation across mission profile conditions. The fuel efficient tires would be compared with conventional tires and measurement of fuel savings calculated. Deliverables for this phase would be prototype tires, and test report of tire testing on FMTV vehicles. This technology is applicable for all wheeled DOD-wide vehicles.

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KEYWORDS: Rolling Resistance, Wet Traction, Chip Resistance, Tear Resistance, Fuel Economy, Tread Wear

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A13-068 TITLE: Advanced Human Robot Interaction to create Human-Robot Teams

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: PEO Ground Combat Systems

OBJECTIVE: Develop the human robot interaction technology to better integrate robotic mule platforms such as the Legged Squad Support System (LS3) or Squad Mission Support System (SMSS) with human operators by improving the mode of interaction, the model of the human operator's intent, and the ability of the platform to communicate its intent to the human operator.

DESCRIPTION: Recent robotic advancements such as the Legged Squad Support System (LS3) and the Squad Mission Support System (SMSS) are poised to change the way that the dismounted squad manages their physical burden. However, due to unreliable or unnatural interactions with robotic systems, there is the potential for robotic mule platforms to replace the soldiers' physical burden with the mental workload of operating and monitoring a robot. In order for the vision of a robotic mule to be realized, there needs to be a dramatic shift in the way that the operator interacts with the robotic mule platform as well as how much the robotic mule platform is aware of the human(s) that are being supported.

The imagined use case is long periods of monotonous following behavior punctuated by intense bursts of activity where the operator does not have time to scroll through user menus to tell the robot what to do. The robot should intuit the intent of the operator in this situation to keep out of the way, head to an objective, shut down, etc.

To address the above challenges, this topic is focused on three primary objectives: 1) a natural mode of interaction, e.g. voice commands through radio, direct voice commands, gesture recognition, passive visual following, etc., 2) an ability for the robot to intuit higher level human operator intent, using features such as the high level mission plan, situational stress, and previous command history 3) the ability of the robot to communicate its intent to the human operator in a heads-up, hands-free, non-intrusive way.

This SBIR assumes an adjustable autonomy already exists on the robot which can scale from full obstacle avoidance, GPS waypoint navigation down through teleoperation and remote control. This SBIR will leverage this adjustable autonomy of the robot and develop a model of the operator's intent that can influence the level of autonomy that the robot performs at in a given situation and that can adjust the amount of interaction that the robot platform demands from the human operator.

This topic is not focused on developing new human robot interaction modalities. Joysticks, speech recognition, machine vision, haptic devices, etc. have been studied extensively and these existing interaction modalities are believed to be sufficient to achieve the goals of this SBIR when adapted and incorporated into a natural Soldier Machine Interface (SMI). Separately, these modalities have been demonstrated, but a Soldier Machine Interface (SMI) that naturally integrates these different techniques has not been shown. Unless revolutionary and quantitative improvements in the efficacy or performance are reasonably expected, this SBIR will not fund the development of new interaction modalities. Additionally, it is expected that only a portion of the possible interaction modalities will be successful enough to incorporate into the robotic mule platform. Thus, a sufficient number of initial approaches should be pursued to improve the chance of final success.

PHASE I: Currently, the Soldier Machine Interface (SMI) for robotics is some sort of ruggedized laptop. Not only does this add weight to the dismounted soldier, it requires them to operate the robot with menu screens and joysticks. In Phase I we seek a System Architecture that will allow the soldier to operate the robot in a heads-up, hands-free way.

During Phase I, the prototype SMI will be designed. Define sensor, processor, and software requirements. Propose metrics for highlighting the impact and reliability of this SMI methodology. Define a minimal lexicon for interaction with the robot (no more than a dozen commands such as start, stop, follow closer, follow side-by-side, turn, slow down, etc.). The design for robot communication with the operator must be heads-up, hands-free, and light weight.

Deliverables: A Phase I report highlighting the work above on the concept of operations (CONOPS), the design of the SMI, and its reliability metrics.

PHASE II: Integrate a fully functional SMI onto an operationally relevant platform such as the LS3 or a surrogate platform (e.g. All-Terrain Vehicle, ATV). Demonstrate the effectiveness of this novel SMI using the metrics defined in Phase I. The SMI should be robust to ambient noise, sunlight, occlusions between the robot and the leader including the leader moving off the camera frame and multiple soldiers, i.e. 9 squad members, in the environment. The objective is MIL-STD-810 compliance.

Deliverables: Phase II shall deliver a RELIABLE heads-up, hands-free device for controlling the robot. The spirit of this topic is to integrate the robot into the squad to the fullest extent possible, and keep soldiers' focus on their primary mission. A Final Report shall detail the progress made during the course of the research. A final demonstration will show the SMI fully integrated with the mule robot or a mule robot surrogate.

PHASE III: Work to have the proposed system become a part of a program of record such as Squad Machine Equipment Transport (SMET). It is imagined that this human interface technology could also be applied to industrial or home robotics as well.

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KEYWORDS: Human Robot Interaction, Human Robot Interface, Soldier Machine Interface, Human Machine Interface, Trust in Autonomy, Leader-Follower, Soldier Load

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A13-069 TITLE: Friction Material (brake pads) for Metal Matrix Drums

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO Ground Combat Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: To develop dual-use friction material (brake pads) for use with the new family of aluminum metal matrix composite (AL MMC) brake drums for use on both unique military applications and commercial vehicle brake systems.

DESCRIPTION: Aluminum MMC (Al MMC) brakes can provide significant weight savings, increased fade performance, lower operating temperatures, increased corrosion resistance and longer component life on a wheeled vehicle braking system[1][2]. Metal matrix composite brakes provide benefits to both military and commercial vehicles by reducing fuel requirements and reducing life cycle costs. These benefits are in alignment with S&T focus area 4b. "Sustainability/Logistics-Transport, Distribute & Retrograde as the increased reliability of the tactical trucks will increase the reliability and timeliness of supplies. This product will reduce brake fade and thus increase vehicle safety while increasing the efficiency by increasing vehicle payload or improving fuel economy. Inherent lower operating temperatures, resultant of increased thermal capacity and thermal conduction, of AL MMC brakes both increase the life of the braking components and increase the fade performance of the braking system. Al MMC brakes have much better corrosion resistance than cast iron components which eliminates the “brake stick” phenomena that cast iron brakes exhibit after sitting in a wet or salty environment for a period of time. Al MMC brakes operate with a transfer layer between the brake drum and the friction material which creates very little wear of the brakes resulting in increased life of the brakes as compared to cast iron.

Typical friction solutions for cast iron brake systems are not applicable to Al. MMC brake components due to higher operating temperatures of cast iron. To realize the full benefits of AL MMC brakes the matching friction material has to be chosen. The material will provide sufficient frictional torque to the brakes during normal and extreme operating conditions while also providing the static holding torque required for parking on grades up to 60% for military vehicles. To achieve these performance requirements a material with the correct coefficient of friction has to be chosen that provides a balance between brake stopping power and static holding torque. The variables that affect the frictional torque requirement for a vehicle include gross vehicle weight (GVW)and tire diameter, the braking performance requirements which include the vehicle speed and deceleration requirement (stopping distance) and the brake system which uses various mechanisms such as wedges or cams to generate force applied to the friction material. With all of these variables changing for each application, the frictional requirements are also unique. As there are families of friction materials that have been developed and tested for various applications regarding cast iron brakes, friction materials have to be developed and tested for various applications regarding AL MMC brakes as well.

The objective of this topic is to develop a family of friction materials compatible with AL MMC brakes for both military and commercial applications. This family of friction materials would consist of a base formulation that is optimized for AL MMC brake drums. Modifications can be made to this base formulation to further develop solutions based on specific vehicle parameters and operating conditions. The friction materials developed will target current medium to heavy wheeled vehicles that employ various brake actuation systems such as S-cam, single wedge and dual wedge, among others. The appropriate friction material will generate consistent dynamic and static braking torque as well as providing long life and not doing any irrevocable damage to the AL MMC brakes for a given application. It would also be desirable for a given friction material to be used for multiple military and commercial applications.

PHASE I: Identify base formulation materials to match the operating characteristics of al. MMC brakes, the goal is to create a family of friction materials which will operate at the lower MMC brake operating temperature and optimize the friction characteristics of the ceramic/aluminum MMC drum/rotor formulas. Determine reinforcement and additive materials for each unique application. These materials will fall under the classifications of binder, filler, abrasives, lubricants, and fillers. Start catalog or spider diagram demonstrating various formulations and potential applications for each. Create a development plan that includes friction formulation development, testing and production along with identification of military and commercial vehicle platforms.

Metrics for evaluating reinforcement and additive materials include their effect on ultimate friction level, effect on stopping distance, effect on fade response, effect on recovery response, noise vibration harshness (NVH) concerns, effect on the wear of friction material, effect on the wear of al. MMC brake drum, and the any swell or growth concerns that could arise due to various operating conditions such as extreme cold weather or salt spray.

PHASE II: Optimize base friction materials for stopping distance, fade performance and durability of both the brake drum and pad while operating at the lower MMC temperature while optimizing the friction characteristics of the ceramic/aluminum MMC drum/rotor formulas under varying application forces (each brake system applies forces in a different manner). Focus will be on current military and commercial, medium and heavy vehicles with GVW's of 25,000 lbs and above.

Main metrics will be cost, coefficient of friction and wear. Typically there is a trade-off between coefficient of friction and wear rates, certain materials can have high coefficient of friction, but high wear rates will also be evident. There are various brake actuation systems that are common to commercial and military trucks including single wedge, dual wedge, and S-cam systems. Each of these systems has a different brake factor and to meet these brake factors varying levels for coefficient of friction are required. The main goal of Phase II will be optimizing individual formulations within the larger family that work for each brake system.

Coefficient of friction will be evaluated utilizing the SAE J661 procedure [4] with an aluminum MMC brake drum (effectively a coupon test). The full scale materials can then be evaluated on a dynamometer utilizing the FMVSS 121 Performance Test [5] and ATPD 2354 Jennerstown Fade and Laurel Mountain Hotstop among others.

Some of the Phase II deliverables may be subject to International Traffic in Arms Regulation (ITAR) control if ITAR controlled vehicle parameters are part of the dynamometer test plan.

PHASE III: Currently General Dynamics Land Systems is testing US Army developed and supplied AL MMC brake drums (using brake pads optimized for cast iron brake drums, so optimal performance will not be realized) for the purpose of adopting this technology on future LAV and Stryker suspension upgrades. This SBIR's optimized brake pads will be implemented concurrent with the AL MMC drums. Commercial interest includes Bendix and Webb wheel, the on highway semi-truck is the leading candidate for this technology and could use a common solution to our 915/916 truck platforms. Final feasibility and material performance assessments will be completed during phase III. Integrated friction formulations for existing product lines including commercial, military, and industrial will be provided for US Army use.

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KEYWORDS: dual-use; brakes; aluminum; metal matrix composite; wedge brake; s-cam brake; stopping distance; lightweight; friction materials; weight reduction; fade

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